Electrical Review

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Switch and Control Equipment at Niagara Falls

Precautions Taken to Guard Generating Apparatus—Indicating Devices and Instruments Important Factors in Station Operation —Switchgear for Main Generating Units Housed in Substation

By STEPHEN Q. HAYES

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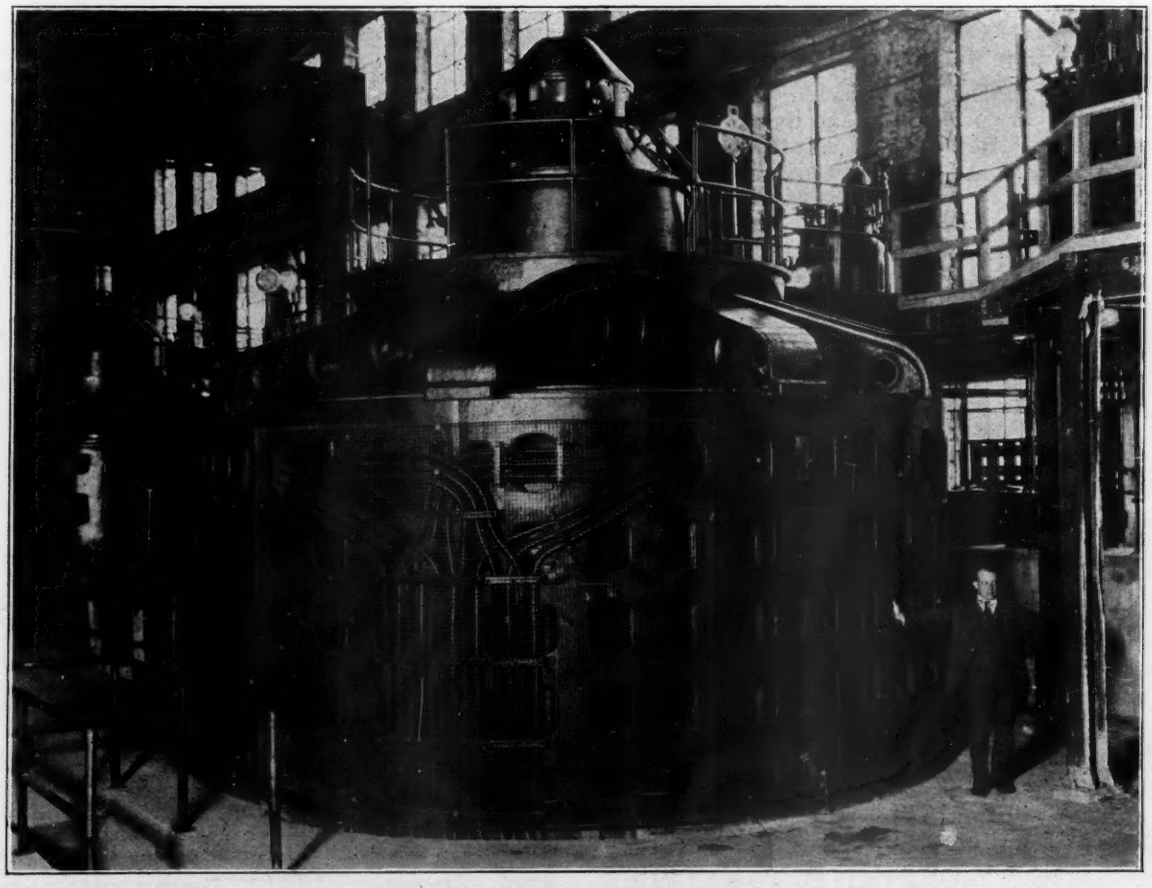
The Niagara Falls Power Co. of Niagara Falls, N. Y., as at present constituted is a consolidation of the system formerly known by that name, the system previously called the Niagara Falls Hydraulic Power Co. and the Cliff Electrical Distribution Co. This consolidation was carried through to permit the most advantageous use of the water allotted for power development to the United States in the treaty with Canada. A site immediately adjacent to the No. 3 power house of the former Niagara Falls Hydraulic Power Co. was selected as offering the best and quickest means of developing additional power, and in this extension shown in an accompanying illustration were installed three vertical-shaft water wheels each driving a 32,500-kv-a., 12,000-volt, 3-phase, 25-cycle generator, these units being numbered 16, 17 and 18 and forming an extension to the existing system.

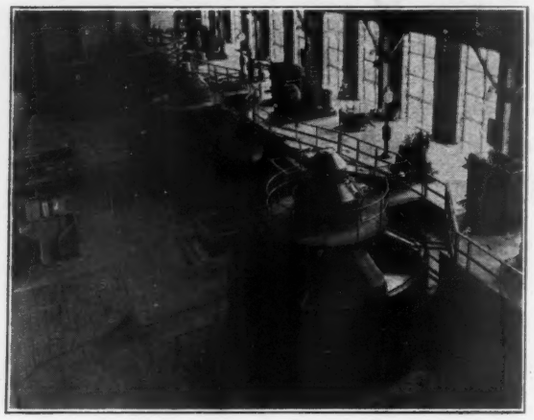
Unit No. 16 comprises an Allis-Chalmers tur-



Generator No. 16 in Plant of Niagara Falls Power Co., Showing Main Leads.

bine driving an Allis-Chalmers generator; unit No. 17 has an I. P. Morris turbine driving a General Electric generator, and unit No. 18 is made up of an I. P. Morris turbine driving a Westinghouse generator.

Descriptions of the hydraulic and electrical features of the plant have lately been given much attention, but comparatively little has been published relative to the switchboard equipment. This article will describe the switchgear for the control of the three 32,500-kv-a., 12,000-volt, three-phase, 25-cycle generators installed in the extension of No. 3 station as well as the equipment for



General View of Generating Room and Exciter Gallery.

the three 12,000-volt transmission lines of similar capacity and voltage running from the generating station to the Echota substation and the various incoming and outgoing feeders at these plants.

Each Generating Unit Considered as an Independent Power Plant.

Each generator is considered practically as an independent power plant, and its connections are run through to the Echota substation three miles away, where it normally furnishes energy to its own group of feeders. Provision is made at Echota for paralleling the three new units with each other or with other parts of the system.

In describing this switching equipment it is the intention to start with the basement of the generating station, pass to the main floor, then to the control gallery in the station and to the terminal-building control room and switchhouse at the top of the cliff, proceeding from that point to the Echota substation and taking up there the various features in connection with the equipment utilized in that station.

As shown in the illustration of unit No. 16, there are 12 cables forming six sets of leads, with two cables in parallel, brought out from the generator winding. The leads brought out from the neutral end of the winding are run through current transformers located on a concrete wall in the basement beneath the generator. These current transformers have a ratio of 2000 to 5 amperes, and are used in connection with corresponding current transformers of the same ratio that are also located on another concrete partition in the basement.

These two sets of current transformers are balanced against each other to operate the differential relays that are located on the generator relay panel. These differential relays only function in case of an internal short-circuit on the generator winding. When they do function they trip out the generator circuit-breaker located at the top of the cliff, and also trip out the electrically operated field switch so as to completely cut off both the armature and field circuits of the generator.

Current Transformers in Generator Neutrals Connected to Ammeters.

In addition to the three 2000 to 5 ampere current transformers in the neutral leads from the generator, a single current transformer having a ratio of 1000 to 5 is connected between the generator neutral and the neutral bus, a disconnecting switch being provided to isolate the generator neutral from the neutral bus. This current transformer in the neutral circuit is utilized for the operation of the neutral ammeter. This type of current transformer, built to slip over bare copper straps, is normally designed for service on voltages not exceeding 3500, but especially long bushings were provided with these transformers to insure sufficient surface insulation for 12,000-volt service. As the neutral is grounded through a resistance the bushings on the transformers in the neutral circuits could have been made of normal length, but it was deemed best to have the transformers interchangeable with those in the main phase leads.

On the main generator floor in the power house underneath the exciter gallery, as shown in an accompanying illustration, there are various structures containing circuit-breakers, disconnecting switches and busses for the local-service equipment.

The 2200-volt supply circuit for the local service normally comes from two 1000-kv-a. transformer banks located in the old No. 3 power house and supplied with energy from the present generating station which contains eight 8500-kv-a. 12,000-volt, horizontal-shaft, water-wheel generators. Provision is also made for a connection from the present 2200-volt service bus in station No. 3 gate house.

Provision Made for Local-Service Generators for Future Installation.

At a later date, when the number of units in the extension to the power house is increased, it is probable that special 2200-volt generators will be furnished to supply energy for station service.

Relay and Terminal Board Used in Connection With Main Switchboard.

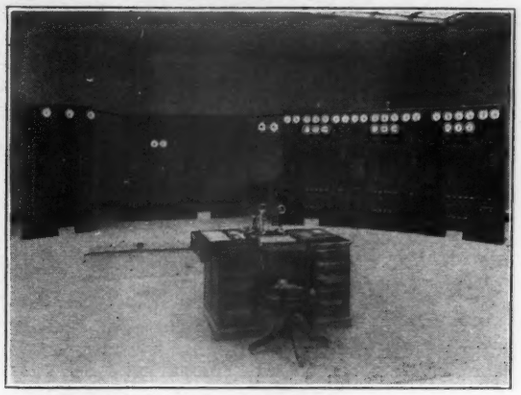
These generators will probably be of about 5000-kv-a. capacity, and all of the automatic circuit-breakers are designed capable of handling the output of two 2200-volt, 25-cycle generators in parallel, assuming that these units will have a reactance of about 12%. They will also handle whatever energy can be delivered through two 1000-kv-a. transformer banks with the voltage maintained on the high-tension side of these banks.

Circuits of the two 1000-kv-a. transformer banks and the gate-house circuit pass through disconnecting switches and current transformers to the type E-9 circuit-breakers located in a structure as shown in an accompanying illustration. These circuit-breakers have their three poles each in a separate tank mounted on suitable supports, all three poles and the operating mechanism being located in a single masonry compartment 4 ft. 6 ins. wide. They are provided with lap-welded elliptical steel tanks and steel tank supports, the tanks being thoroughly grounded. Individual tanks inclose the contacts of each pole of the breaker, the tanks being removable without disturbing the operating mechanism or contacts. This type of construction makes inspection easy. Ample air space is provided at the top of the tank to allow for proper gas expansion.

These circuit-breakers have terminal rods with stationary contacts at the lower extremities supported by one-piece, vertical, pillar-type, porcelain bushings clamped to the circuit-breaker tops. The studs and micarta tubing details are clamped to these insulators. This construction avoids the use of babbitt and reduces the expense and labor for maintenance. The main contacts are of laminated-copper-butt, end-on, high-pressure, self-cleaning construction. The main moving member consists of a laminated-copper brush bearing on stationary contact surfaces kept clean by the movement of the brush. When the high contact pressure, secured by the mechanism of this type of equipment, is impressed on the moving contact the contact surface spreads out on the stationary contact producing a wiping or self-cleaning action during the motion of closing and opening. All of the contact pressure reacts vertically downward to assist the action of gravity and the accelerating spring in the opening operation.

Stationary contacts with horizontal surfaces are mounted on the lower end of the terminal stud and provide a liberal contact surface. The moving contacts of each pole are connected to the mechanism by a rod. The insulating portion of this rod is of treated wood, but the part of the rod that passes through the top of the breaker is made of steel, this part being of small diameter to make the area exposed to the internal gas pressure as small as possible. The gas pressure in the tank therefore has little tendency to retard the motion of the contact when opening. A contact pressure of approximately 100 lbs. per sq. in. is obtained by adjustable features which equalize the pressure on both ends of the moving contact element.

Arcing contacts of the butt type protect the main contacts at the time of opening the circuit. The moving member consists of a spring plunger and copper arcing tip mounted on the support of the moving contact. A flexible copper-wire shunt carries the current from one plunger to the other, keeping the resistance of this circuit low and reducing to a minimum any arcing on the main contacts. A copper bolt is carried on the contact foot, the head serving as a stationary arcing contact. The auxiliary arcing plungers maintain contact for a considerable distance after the main contacts have parted and serve to protect the main contact.



Main Switchboard in Control Room.

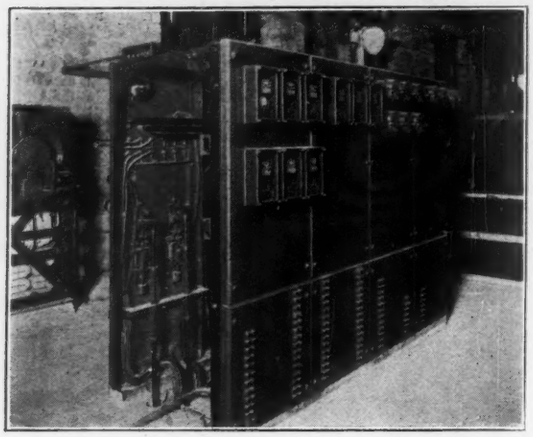
The scheme of excitation employed in the station utilizes a separate motor-driver exciter for each generator, omitting any main generator rheostat and securing proper voltage control by an automatic regulator working on the exciter field. As an emergency measure provision is made for cutting in a series rheostat in the field circuit of any generator. This excitation arrangement is a modification of that originated for the plant of the Ontario Power Co. at Niagara Falls, Ontario. The motor-driven exciters are 225-kw., 250-volt machines driven by 2200-volt induction motors, and each unit is normally used for supplying the field current to one 32,500-kv-a. generator.

Switchboard Provided for Control of Each Exciter Unit.

Each of the motors-driving exciters used with the main generators is provided with a switchboard as shown in an accompanying illustration. Energy for the motor that drives the exciter can be obtained either from the 2200-volt excitation bus or from a reserve bus through suitable oil circuit-breakers and disconnecting switches. These supply energy to the short section of bus to which is connected an autotransformer and a mechanically operated double-throw oil circuit-breaker so connected that the induction motor may be connected to the low-voltage taps of the autotransformer for starting and to the full-voltage taps for running. The electrically operated F-2 circuit-breakers are provided with independent poles and are mounted on a suitable pipe framework in the compartment. The hand-operated, single-throw circuit-breaker on the primary side of the autotransformer and the hand-operated, double-throw circuit-breaker used for the starting and running positions of the induction motor are also of the F-2 type, all three poles, however, being located in the same tank.

The oil tanks of the three-pole, F-2, manually operated, remote-control, 300-ampere, 7500-volt circuit-breakers are of rectangular shape and are

made of heavy sheet iron with all seams lap-welded, the bottom being flange welded on the outside of the tank. As an additional protection from arcing, individual insulating cells are provided to form separate compartment for each pole



Relay Board at Back of Local-Service Switchboard.

where one tank is used on multiple breakers. The tanks are deep enough to allow ample space above the oil level to act as an expansion chamber for the arc gases and to reduce slopping of the oil from internal disturbances. The gases are vented through the clearance between the wooden operating rods and the frame.

Excitation and Local-Service Boards Mounted on Generator-Room Balcony.

Above the structures containing the oil circuit-breakers is located the operating gallery containing various switchboards, as shown in the general view of the generator room. On this gallery there are three 3-panel duplex switchboards used for the control of generator excitation and one 4-panel board for local service. These duplex switchboards consist of two set of panels mounted back to back 3 ft. on centers.

An accompanying illustration shows a front view of the local-service switchboard. The panel on the left contains the operating handle for the three-pole, mechanical-control, F-2 circuit-breaker on the primary side of the autotransformer used with the pump motors, and also the apparatus for a second circuit. The next two panels each contain a 50-ampere ammeter and the operating handles for the three-pole, double-throw F-2 circuit-breakers used in the governor-pump circuit. One throw of the circuit-breaker connects the pump motor to low-voltage taps of the autotransformers for starting and the other throw, with the automatic protection, connects the motor directly to the 2200-volt bus for running. The panel at the right-hand end of the board contains the operating handles for two 3-pole, distant-mechanical, type A starters used for the oil-pump circuit, these starters being connected to the middle studs of the three-pole, double-throw knife switches that are mounted on the upper part of the panel.

Back to back with this switchboard is the relay board shown in another illustration. The panel to the left contains two sets of three single-phase reverse-power relays operated from current and potential transformers in the incoming circuit of the 100-kv-a. local-service transformers. These relays operate in such a manner that if power is sent back over these circuits the circuit-breakers will be opened. Suitable calibrating and adjusting terminals on the lower section of this and similar panels are furnished to permit opening up any control or transformer circuit for the purpose of adjusting and testing.

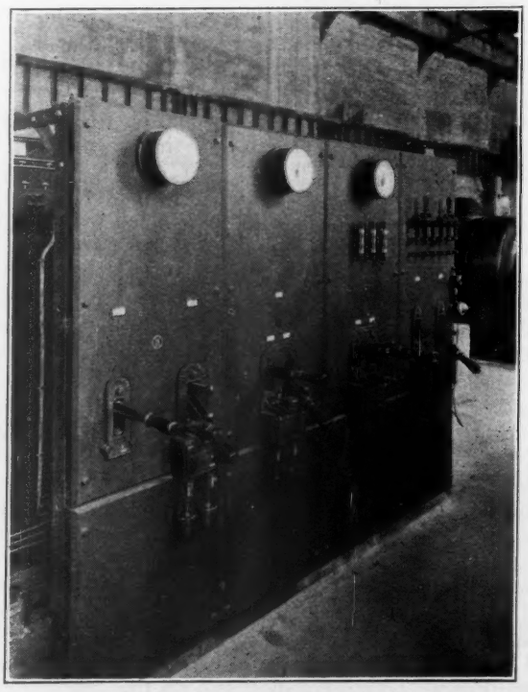
The second panel is provided with reverse-power relays operated from current and potential transformers in the circuit connecting to the gate-house bus so that when power is transmitted in the reverse direction over this circuit the circuit-breaker will be opened.

The third panel contains the overload relays controlling the E-9 circuit-breakers feeding the 2200-volt exciter bus and the 2200-volt reserve bus. The last panel contains three overload relays used in connection with the circuit-breaker supplying the transformer used with the 220-volt station bus. This panel is also drilled for future bus relays to be used in connection with the circuit-breaker in the circuit to the 2200-volt bus.

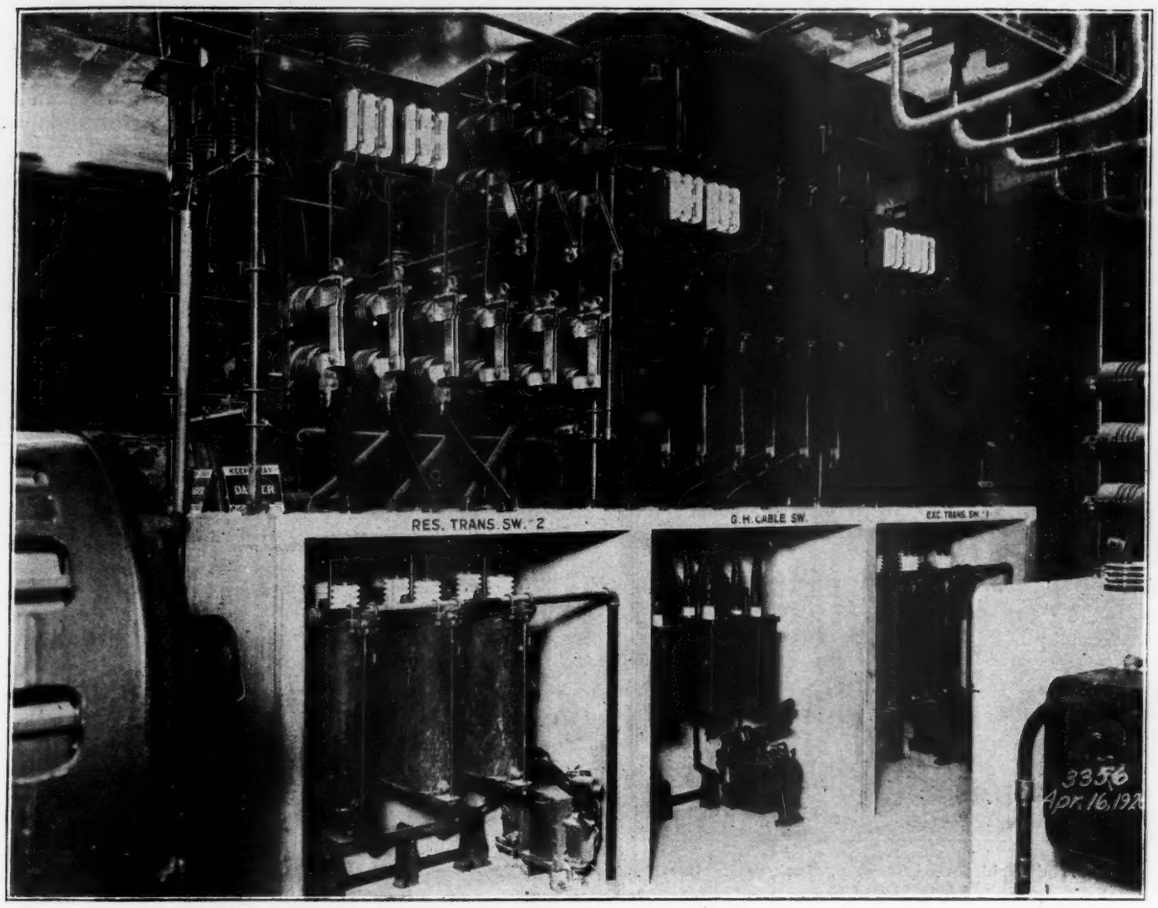
Exciter and Generator Field Regulated From One Switchboard.

There are three 3-panel duplex switchboards used for the control of the 225-kw. motor-driven exciters, the ventilating fan and the field circuit of the 32,500-kv-a. generators. On each of these switchboards one panel contains a three-pole, double-throw knife switch and the operating handle for use with the distant-mechanical-control autostarter serving the 220-volt blower motor used for generator ventilation.

The second panel contains an a-c. generator ammeter, a field ammeter and an exciter ammeter for the information of the operator on the gallery in the generator room, although these machines are actually controlled by the switchboard operator in the control room. Below the three indicating instruments is placed the engine-room



Local-Service Switchboard.



Structure for Circuits From Local Transformers—Circuit-Breakers Are Shown in Their Compartments.

signal containing six single-pole, double-throw switches and indicating lamps, the lamps being placed behind translucent glass.

Near the bottom of the main slab of this second panel is located a two-handle coverplate controlling the double-throw F-2 circuit-breaker on the floor below that will connect the induction motor to either the low-voltage taps of the autotransformer for starting or to the full-voltage taps for running.

On the third panel near the bottom of the main slab is located a single-handle coverplate which controls the three-pole, mechanically operated, F-2 circuit-breaker on the floor below used for connecting the autotransformers to the 2200-volt bus.

Above the circuit-breaker operating handles are placed card holders and red and green indicating signal lamps to show the position of the exciter oil circuit-breaker, the exciter d-c. circuit-breaker, the generator-field switch, the d-c. bus and the reserve oil circuit-breakers. Near the top of the panel are placed overload relays used in connection with the exciter equipment, and directly below these are the differential relays operated from current transformers in the generator circuit and used for tripping out the generator oil circuit-breaker and the generator-field switch.

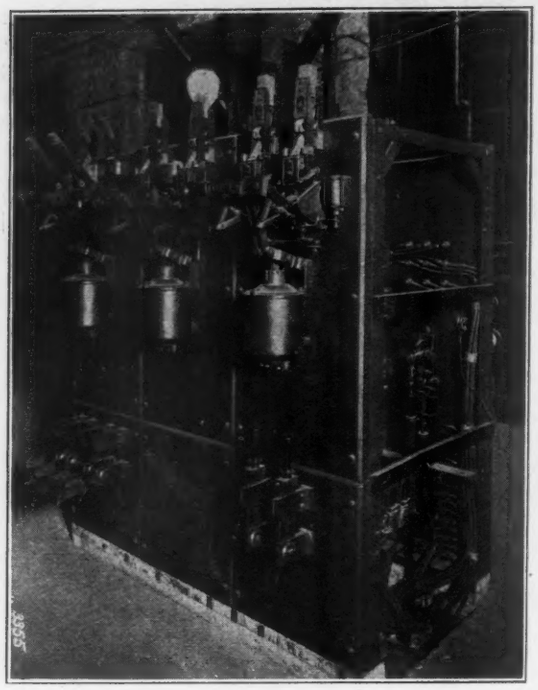
The bearing housing of the generator and the d-c. end of the motor-driven exciter set are to the left of the switchboard, while the governor mechanism and the penstock-valve position indicator are to the right of the board so that the operator on this gallery is convenient to everything that may need his attention.

Set back to back with this board is the switchboard containing the solenoid-operated carbon circuit-breakers and field switches used with the main excitation circuit and the field circuit of the a-c. generator.

The left-hand panel contains a two-pole, solenoid-operated circuit-breaker with a total of four single-pole, single-throw knife switches with the connections so made that the excitation bus on the rear of the board can be fed through the motor-operated rheostats, shown in an accompanying illustration, from the d-c. bus in station No. 3. This is an additional precaution that has been taken so that in case any motor-driven exciter is out of commission the corresponding generator can have its field circuit properly regulated by means of the usual type of motor-operated rheostat in the field circuit. Under normal conditions there is no rheostat in the generator circuit, all of the control being taken care of by means of the exciter-field rheostat.

The middle panel contains the solenoid-operated, two-pole, carbon circuit-breaker with the field-discharge attachment used in the field circuit of the 32,500-kv-a. unit. On the back of this panel is located the ammeter shunt used with the field ammeter on panel No. 2. The right-hand panel contains the two-pole, solenoid-operated circuit-breaker and the two knife switches in the main circuit from the motor-driven exciter. The various solenoid-operated circuit-breakers are provided with suitable contactor switches on the rear of the panel so that the control switches do not have to carry the current

needed for the operating of these heavy carbons circuit-breakers. Two rheostat face plates with their resistors, shown with the local-service relay board, are connected in series to give a greater number of steps for the purpose of securing



Exciter and Field Switchboard at Back of Exciter-Motor Board.

finer voltage adjustments. Ample ventilation for the resistor grids can be secured from the window immediately back of them.

The local-service switchboard is shown as the central board in the control room. The first panel on the left connects the 220-volt, a-c. bus supplying various lighting circuits. The second panel controls the motor-driven charging set, consisting of a 14-kw., 250-volt, d-c. generator and a 20-hp., 220-volt, three-phase, 25-cycle induction motor. The three-pole single-throw switch with fuses on the lower slab, fed from the 220-volt, a-c. bus, supplies current to the type A autostarter that is distant controlled from the operating handle located on the upper slab of the panel. The two-pole knife switch and the two-pole circuit-breaker are in the main circuit from the d-c. generator to the battery circuit. The circuit-breaker shown on this panel is a two-pole equipment with overload coil and reverse-current attachments to disconnect the d-c. machine in case the battery tends to feed back into it, the battery being left in service to furnish energy to the control circuit. The instrument on the left is a d-c. voltmeter with a voltmeter switch directly below so that the voltmeter can be connected across the exciter, control bus or battery. The instrument on the right is a double-reading ammeter in the battery circuit calibrated at 50-0-200 amperes. The field rheostat used in the circuit of the 14-kw., d-c. generator is directly below the ammeter.

The third panel is used primarily for the control battery and for the circuit to the emergency transfer switch used for connecting certain lights either to the battery or to the d-c. current. The control battery is a 220-volt, 120-ampere-hour storage battery comprising 110 type E-7 cells having a discharge rate of 15 amperes for 8 hrs. and 60 amperes for 1 hr. The remaining panels contain two-pole fused switches used for supplying the current needed for the control circuits. Three panels at the left of the switchboard each contain a 300-volt a-c. voltmeter with a voltmeter switch and two circuit-breaker control switches with red and green indicating lamps, these controlling the E-9 and F-2 electrically operated circuit-breakers in the incoming circuits from the station-service transformers and in the various bus and feeder circuits.

Switchboard for Control of Main Generating Units.

The switchboard on the right is the control board for the three main units, Nos. 16, 17 and 18, and consists essentially of three 3-panel boards arranged tangent to a circle 21 ft. in diameter. The left-hand panel of each of the generator boards for units Nos. 16 and 17 has one 300-volt d-c. voltmeter connected across the terminals of the generator field to indicate the approximate field current of the unit. Owing to the distance of approximately 400 ft. between the location of this panel and the location of the generator-field switch a field voltmeter was much simpler to operate than a field ammeter which would have to have extremely long shunt leads.

This panel of the first two boards also contains a d-c. millivoltmeter, calibrated as a temperature indicator, with six receptacles to permit cutting the temperature indicator into the circuits of any of six search coils placed in the windings of the generators No. 16 and 17. The panel also contains the rheostat hand wheel and the type AE-4 voltage regulator with its control element, rheostat-shunting relays, transfer switches and similar devices for the proper control of the field circuits of the 225-kw., 250-volt, motor-driven exciter. On the lower section of the regulator panels are placed the relays used for guarding against excess voltage conditions that might arise from the sudden opening of a feeder circuit-breaker after a short-circuit when the regulator had moved to such a position as to keep the generator voltage up to a maximum. The left-hand panel for unit No. 18 is similar to panel No. 1 of the other units, omitting the millivoltmeter for temperature indication and the temperature plugs,

Exciter, Exciter-Motor Switchboard and Governor Mechanism of Unit No. 16.

as the temperatures of this generator is measured by thermocouples. The middle panel of each of the three switchboards has mounted at the top a signal lamp used in connection with the annunciator to call attention to the operation of certain relays. Near the top of the panel are located three 2000-ampere a-c. ammeters, one polyphase indicating wattmeter, one 18,000-volt a-c. voltmeter and one power-factor indicator.

Further down on the panel are placed a three-way voltmeter switch and an eight-drop gravity annunciator. The annunciators are provided with metal cases and have electrical set-backs and

End View of Exciter Gallery and Space Below.

lamp signals. The electrical set-back permits the replacing of the drop by means of a push button, and the lamp signal and alarm bell call the attention of the operator to the fact that a certain device has functioned. There are two push buttons, one stopping the alarm bell and the other resetting the annunciator. Below the annunciator is located the voltage-adjusting rheostat used in connection with the regulators. The reset push buttons used with the annunciator and bell alarm are located on either side of the hand-wheel of the voltage-adjusting rheostat.

There are five control switches near the bottom of the main section and four near the top of the lower section used for the control of the exciter-field rheostat, the d-c. bus circuit-breaker, the generator-field circuit-breaker, d-c. exciter circuit-breaker, the governor motor, the exciter-field switch, the d-c. bus rheostat and the circuit-breakers connecting to the 2200-volt reserve bus and excitation bus. Suitable card holders are mounted to show the functions of the various breakers.

Thermocouples Used to Indicate Temperature in Generator Windings.

On the third panel of each switchboard is located a 1000-ampere ammeter in the circuit from the generator neutral to ground, a frequency meter, a six-circuit signal box and a push button to call the operator's attention to the signal. A control switch and indicating lamps for the generator oil circuit-breaker, and a synchronizing receptacle with electrical interlocks are also provided. The third panel for unit No. 18 has, in addition to the apparatus previously mentioned, a potentiometer and a six-point dial switch to provide for reading the temperature at six points in the generator winding by the action of thermocouples.

Owing to the distance of approximately 400 ft. between the location of the thermocouples in the machine and the equipment on the panel the temperature leads, instead of comprising a seven-conductor cable with six copper leads and one alloy lead, have been made up by the use of six twin-conductor leads, each twin-conductor comprising one copper conductor and one alloy conductor. The six alloy conductors of the various circuits are all connected in parallel to secure greater conductivity.

On the relays and terminal boards, located on the floor below the control room, the center panels contain three overload relays operated from the 2000 to 5 ampere current transformers connected in the generator circuit and located in the terminal building. Below the relays is placed a polyphase graphic wattmeter, and below that a polyphase watt-hour meter.

Control and instrument wiring is run in the form of multiple-conductor cable. Wherever these cables are run horizontally for any distance they are placed on racks. From the racks the multiple-conductor cables are taken in iron conduits covered in by the cement floor to the rear of the control switchboard where connections are made to terminals that permit the ready testing of the control circuits and the calibration of instruments and relays.

(To Be Continued.)

DUTIES OF PENNSYLVANIA UTILITY OUTLINED.

In sustaining a complaint of the borough and local manufacturing interests of Palmyra against the Annville & Palmyra Electric Light Co. service, the Public Service Commission of Pennsylvania says: "Many of the interruptions could have been avoided by frequent and regular inspection and prompt remedial measures where trouble or fault was encountered." The company is ordered to make a thorough inspection of its transmission and distributing circuits and make necessary repairs within 30 days, also to install adequate lightning protective devices, and complete the construction of its new substation at Palmyra before next April.

CONTINUOUS-WAVE SET DISCUSSED AT RADIO MEETING.

The Radio Club of America held a meeting Dec. 23 in New York City, the feature of which was a paper by J. O. Smith describing in detail the amateur continuous-wave radio set used at station 2ZL, which is a well-equipped amateur station in the second district of New York. The constants of different parts of the apparatus and circuits were given.

ONE-MAN SAFETY CARS ON CHICAGO SURFACE LINES.

The Illinois State Utilities Commission has ordered Chicago Surface Lines to install trailers and one-man cars on light traffic lines, in accordance with the city ordinance of 1918, passed as a war measure, and to submit within 60 days rerouting plans for the downtown section during rush hours.

Insulation of High-Voltage Transmission Systems

Twelfth of a Series* of Articles Giving a Review of the Electric Power Situation—Fundamental Laws of the Dielectric Circuit—Dielectric Strength of Insulating Materials—Pin-Type Insulators

By ALFRED STILL

Porcelain insulators used on high-voltage transmission lines are the result of successive developments and improvements in the design and manufacture of insulators originally used for supporting telegraph wires and the low-voltage conductors of the earlier overhead lighting systems. Of recent years the study of line insulation problems has been conducted on scientific lines, and the later developments are mainly the outcome of a more thorough understanding of the fundamental principles involved in their design.

The design of insulators for the lower voltages is a comparatively simple matter, the difficulties becoming greater with the increase of pressure, although the introduction of the suspension type, which permits of many units being connected in series, has considerably simplified the problem.

It is important to bear in mind that every insulator is necessarily a more or less complicated condenser, and it can generally be thought of as consisting of a number of separate condensers in series, the dielectric being alternately air and porcelain. The current passing from line to ground is partly a leakage current over the surfaces (the leakage through the porcelin being generally negligible) and partly a capacity current. This capacity current spreads itself over the high-resistance surfaces of the insulator material in a way which depends upon the surface conductivity and on the spacing and disposition of the various parts. It is well to keep the electrostatic capacity as low as possible, but it is of equal if not greater importance to distribute it by a scientific arrangement of the component parts so that abnormal stresses will not occur locally. These may puncture or damage the insulator at one particular point, while a more carefully designed insulator of lighter weight may withstand a greater total breakdown pressure, because proper attention has been given to this important matter of capacity distribution.

The effect of rain on the exposed surfaces of an insulator is to increase the capacity, and this will generally lower the flashover point, but the increased surface conductivity has the effect of equalizing the potential distribution. In the case of a large number of condensers in series, such as occurs especially with the suspension type of insulator, it has actually been observed that this equalizing of the potential distribution may cause the flashover pressure of the wet insulator to be no lower than the flashover pressure of the same insulator when dry.

*Preceding articles in this series appeared in the July 17, Aug. 7, Aug. 21, Sept. 4, Sept. 18, Oct. 2, Oct. 16, Nov. 6, Nov. 20, Dec. 4 and Dec. 18, 1920, issues of Electrical Review.

If the distribution of dielectric flux could be easily determined in the case of the rather complicated shapes and varying thicknesses of dielectric which occur in high-tension line insulators, it would be an easy matter to predict the performance of new types and sizes under specified conditions. Although the dielectric circuit can conveniently be treated in a manner analogous to the engineer's treatment of the magnetic circuit, there is always difficulty (except in the simplest cases) in predetermining the amount and direction of the lines of flux or stress.

Fundamental Laws of the Dielectric Circuit.

It is not proposed to take up much space in discussing details of design or in explaining exactly how an insulator should be proportioned to fulfill given requirements, but recent progress and the understanding of present-day problems depend so much on an understanding of the flux distribution and stresses in the dielectric circuit that a few words on this subject will not be out of place in this article.

It is equally true of the dielectric as of the magnetic circuit that the chief difficulty the practical designer encounters is in determining the distribution of the flux. He desires to know this in order to ascertain where the concentration or flux density is greatest, because that will be the point where the electric stresses are a maximum and where disruption of the dielectric may occur.

Any arrangement of two conductors with a dielectric between them constitutes a condenser. If the capacity of this condenser is C farads and the difference of potential between the two conductors is E volts, the total dielectric flux in coulombs is:

$$\psi = E\,C \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This so-called flux or quantity of electricity of ψ coulombs should not be thought of as a "charge" which has been carried from one of the plates or metal conductors to the other to the surface of which it adheres, but rather as a condition of stress in the dielectric between the metal conductors. The space occupied by the dielectric is really in a state of strain, something like a deflected spring, and it is always ready to give back the energy stored in it by the applied potential difference as soon as this potential difference ceases to exist.

The dielectric may be thought of as an electrically elastic material which will only give way or be ruptured when what may be called the "elastic limit" has been reached. The dielectric

flux (the quantity ψ) may be imagined as made up of a certain number of unit tubes of induction much as the engineer is accustomed to imagine the magnetic field linking with current-carrying conductors, and when we speak of a coulomb we should have in mind an imaginary unit tube of dielectric flux. It is sometimes helpful to consider the analogy between the dielectric and magnetic circuits. Thus, in place of equation (1) we would write

$$\Phi = \text{M.m.f.} \times \text{Permeance} \quad \ldots\ldots\ldots\ldots (2)$$

for the fundamental law of the magnetic circuit. Here Φ stands for the total flux (maxwells) in the magnetic circuit; m.m.f. (the magneto-motive force) takes the place of e.m.f. (E), and the quantity C in formula (1) is in reality a measure of the *permeance* of the dielectric circuit. Similarly, the *reluctance* of the magnetic circuit (the reciprocal of permeance) may be compared with the reciprocal of the capacity, which is occasionally referred to as the *elastance* of the dielectric circuit.

In order to determine whether or not a particular portion of an insulator is liable to be overstressed electrically, we must know how to predetermine the density of the dielectric flux, or the coulombs per square centimeter of cross-section at the point considered. If ψ stands for the total flux through a given small area of cross-section perpendicular to the lines of flux, the average flux density over that area will obviously be

$$D = \frac{\psi}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where A is the area of the section considered.

The capacity of a condenser consisting of two parallel plates each A sq. in. in area, and separated by a distance l cms. is,

$$C = Kk\frac{A}{l} \text{ farads} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

where K is a numerical constant of value 8.84×10^{-14} and k is the dielectric constant or specific inductive capacity of the material between the two plates of the condenser. This coefficient has the value $k = 1$ for air and $k = 4.5$ for porcelain.

Putting this value of C in formula (1) and then substituting the value for the flux (ψ) obtained in formula (3), we get

$$D = Kk\left(\frac{E}{l}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

But the quantity E/l is what is known as the *potential gradient*, or volts drop per centimeter measured in the direction of the flux lines. This quantity is also called the *electrostatic force* or *electrifying force* and is denoted by the symbol G. We may therefore write the formula (5) in the form

$$D = Kk \times G \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

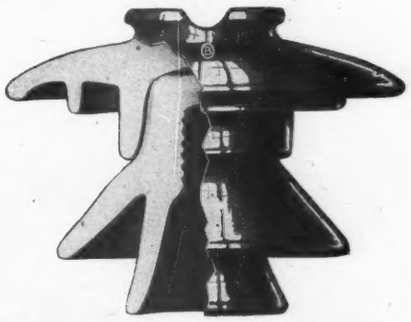
Here, again, the analogy between the dielectric and magnetic circuits may be noted. For the magnetic circuit we would write $B = \mu H$ meaning that the magnetic flux density is the product of the magnetomotive force per centimeter by the magnetic permeability of the material.

The meaning of formula (6) is that the electric flux density is the product of the electromotive force per centimeter by the "conductivity" of the material to dielectric flux.

Dielectric Strength of Insulating Materials.

When the electric stress due to concentration of dielectric flux reaches a certain limiting value the material of the insulator or dielectric will break down. By placing thin slabs of insulating material between two large flat electrodes and raising the pressure between the electrodes until puncture occurs, what is known as the *disruptive gradient* or *dielectric strength* of a material may be ascertained experimentally. The approximate virtual or root-mean-square values of the sinusoidal voltage which will break down a slab of porcelain 1 cm. thick is about 110 kilovolts. What is ordinarily referred to as the disruptive gradient would be $\sqrt{2}$ times this pressure. The dielectric strength of air is only about 22 kilovolts per cm., which must also be multiplied by $\sqrt{2}$ to obtain the disruptive gradient.

Since the electric stress, or voltage gradient (G), as indicated by formula (6), is directly proportional (in a given material) to the flux density (D), it is clear that when the concentration of flux at a particular part of an insulator is sufficient to produce a certain known maximum flux density at the point in question breakdown of the insulation is to be expected. One of the difficulties in insulator design—as previously mentioned—is to map out the dielectric field and determine where the greatest flux density will occur and how near to the breakdown value it is likely to come under conditions of normal and



Two-Part Pin-Type Insulator for Working Pressure of 55,000 Volts.

abnormal voltages which it should be able to withstand. With the accumulation of experimental data and the employment of more scientific methods in attacking the problem, this difficulty is of less importance now than in the past when the higher voltage lines were first constructed.

Insulators Form Condenser Dielectrics.

When two electrical conductors, such as the line wire and the pin support of a pin-type insulator, are separated by dielectric paths through porcelain and air, the problem of calculating the capacity of the condenser so formed differs little from the analogous problem of determining the

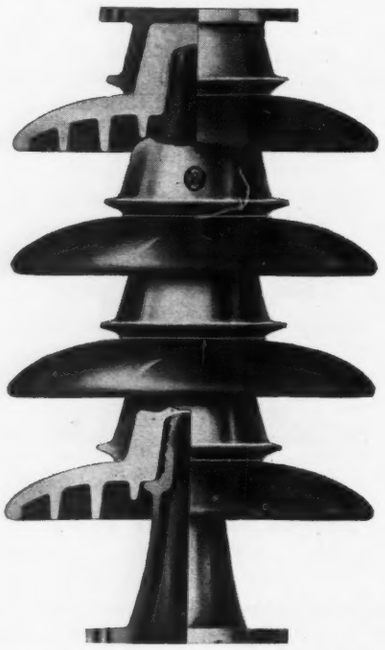
position of the flux lines in the space separating two magnetic poles. There is no mathematical solution applicable to all shapes and relative positions of the parts forming such a condenser, but the well-known law of maximum permeance of "least resistance" may be applied. This law is to the effect that the lines of force and the equipotential surfaces in the dielectric field will always be so shaped and distributed that the permittance, i. e., the capacity, of the flux paths will be a maximum. With experience and patient labor it is possible to apply this law in the mapping out of electrostatic fields even of fairly complicated arrangements of conductors and insulating materials.

In this manner the weakest points in a design may usually be discovered even if the potential gradient at such points cannot be predetermined very accurately.

Effect of Condensers Connected in Series.

The sheds or petticoats on insulators, with air spaces between them, may, as previously mentioned, be thought of as a number of condensers in series between the wire at line potential and the pin at ground potential.

When a number of condensers are connected in parallel on the same source of supply the total dielectric flux is simply the sum of the fluxes in the individual condensers, but when connected in series the flux must be the same for all the condensers. It is convenient in calculations to consider the *elastance*, or reciprocal of permittance, just as in the electric circuit we make use of resistance, and in the magnetic circuit of reluctance, in making the equivalent calculations.



Pillar-Type Insulator Used for High-Voltage Bus Bars, Switches, Etc.

If the capacity of each condenser in the series is known the total elastance is simply $1/C = 1/C_1 + 1/C_2 +$, etc., where C_1 and C_2, etc., are the capacities of the individual condensers. Thus the total capacity (C) of the series may be calculated, and also, by formula (1), the total flux or coulombs for a given potential difference (E) across the series.

If I_c is the charging current and E is the potential difference causing this flow of current through a condenser of capacity C, we have the relation $I_c = 2\pi fEC$; and, when the frequency is constant, $E \propto I_c/C$. Thus, when a number of condensers are connected in series, the current I_c is the same through all the condensers, and the potential difference across any one condenser is *inversely proportional to its capacity*; whence the importance of care in design to avoid too great a stress across a given thickness of porcelain.

The Pin Type of Line Insulator.

With the pin type of insulator a number of sheds or petticoats hanging close to the pin, with small air spaces between them, will not be effective because, although the leakage path may be long, the capacity is high. The remedy consists in spreading the petticoats away from the pin, the outer shed in some designs being almost horizontal. This outer shed has in some cases been replaced by a metal shield. Apart from the advantage of lightness, which permits of a thin metal shed being made of larger diameter than would be permissible if the material were porcelain, the charging current will spread itself more uniformly over the surface of the outer shed and so prevent the concentration of potential at the point where the conductor is tied to the insulator. An insulator of this type may flash over at a somewhat lower pressure than if the upper hood were of porcelain, but under wet conditions the flashover pressure may be higher.

Pin-type insulators are available for pressures up to 70,000 volts, but the suspension type, made up of two or more units, is generally more satisfactory and economical for pressures above 50,000 volts. The pin type of insulator becomes too heavy and costly when designed for the higher voltages, and, owing to the great length of the supporting pin, the bending moment near the point of attachment to the crossarm tends to become excessive.

Modern designs of pin-type insulators, as shown in the accompanying illustrations, have a greater thickness of porcelain than used to be considered necessary in the earlier designs. Other improvements have been introduced lately, one tendency being toward larger head diameters in proportion to the height.

Although the material most commonly used for insulators on overhead power lines is porcelain, glass may sometimes be used to advantage on the lower-voltage lines. This is a cheaper material than porcelain, and it is of high resistance with good dielectric strength. It is, however, rarely used on lines working at pressures higher than 22,000 volts. An exception occurs in the case of the 70,000-volt transmission of the Missouri River Electric & Power Co., Helena, Mont., where about 50,000 pin-type glass insulators have been in use for nearly 14 years.

Some mechanical details of construction, as well as troubles that have recently been experienced with porcelain, and the means of overcoming difficulties that have been encountered with line insulators that have been in service many years, will be discussed in a subsequent article.

Design and Maintenance of Distribution Systems

Standard Construction—Distribution Centers—Periodic Inspection—Line, Transformer and Service Maintenance and Records —Paper Before Southeastern Geographic Division, N. E. L. A.

By R. H. RICE

Engineer, Henry L. Doherty & Co., New York City.

Due to other important work that has required the attention of public utilities it appears that only during the past two or three years much consideration has been given to the proper construction and maintenance of the electric distribution systems throughout the country. It has only been of recent date that central-station companies have given very much consideration to the electric distribution phases of their properties, but due to the necessity of obtaining the maximum efficiency during the recent war period, which made such heavy demands, more consideration has been given to the economy of distribution operation and the elimination of unnecessary losses.

Although considerable progress is now being made along this line and more attention is being given to the methods of new construction, as well as the proper maintenance of the existing feeders, still from the many distribution systems that have been investigated it is evident that there is room for progress in having well-constructed and efficiently operated distribution systems.

A large number of the distribution systems of the country have not been made to keep pace with the developments in this branch of the central-station industry, with the result that the distribution systems have in many cases not received the attention from the standpoint of design and efficiency of operation that they should have received. Much time and energy have been profitably spent in improving the efficiency of boiler-room and generating equipment, and yet a high distribution loss has frequently been permitted to go unchallenged.

As the distribution system represents a large part of the investment, opportunity is offered for large savings in investment and the resulting interest charges by more efficient handling of the present equipment.

As for the necessity of improving the existing systems it is evident from an operating standpoint that a distribution system should be so constructed as to eliminate as many interruptions to service as possible. Also from the point of economy it is quite certain that there are few who do not recognize, to at least a small extent, the amount of energy being lost through the improper location of transformers, the lack of uniform control over flat-rate lighting, having too small primary and secondary copper feeders, inaccuracy of watt-hour meters, to mention nothing regarding the excessive losses due to the theft of energy by the many ingenious methods and devices that have been found on different electric meters and their various connections.

Definite Standards in Construction of Distribution Lines.

The question of standardization in the methods of overhead construction in the past does not appear to have been given the thought and attention that other phases of utilities have received, but from recent indications there appears to be a tendency of late to formulate some definite standards to follow in the methods of construction, as well as the class of material to be used in any new construction or maintenance work.

A short-sighted practice that has been followed in a great number of electric properties in the past is to construct a line at the lowest possible cost regardless of the life of such an extension. Also when it came to the proper maintenance being taken care of on existing lines, the policy was to wait until such lines would hardly stand any longer, and then to reconstruct as cheaply as possible in order to continue service.

No doubt we have all seen a considerable amount of such construction in our travels and finally returned to our own property with the feeling that our construction was not as bad as that we had seen, but judging methods of construction by comparison with poorly constructed lines is a poor method of attaining perfection.

If a comparison were made over a period of years as to the original cost of a new piece of overhead construction together with the maintenance thereon, compared with a poorly constructed line with its corresponding maintenance, it is quite certain that the consensus of opinion would be that it would more than pay to expend considerably more in the original construction than it would to keep continually maintaining the line thereafter. And for the fact that new construction is a capital account which may be capitalized by the issuance of securities, while maintenance work is purely an operating charge, the value of reducing maintenance to an economy consistent with efficient operation of a distribution system can readily be appreciated.

Survey of System Necessary to Construction Program.

In order to intelligently take care of power and lighting loads with the highest efficiency possible in their distribution, one must first thoroughly understand the entire system, and in order to have this information available it is most essential that a careful survey be made of pres-

ent existing feeders, including the primaries and secondaries, and in order to obtain the necessary data, the following is suggested:

(1) In order to understand a distribution system a careful survey must be made of each circuit and a map prepared of the entire system, embodying this information thereon, together with the relative location of the transformers, sectionalizing switches, size of wires, secondary feeders, and the proximity of one circuit to another.

By following definite "legends" (see Fig. 4) in the preparation of this map, it would be a simple matter to make any changes on the original tracing without many erasures, and then from time to time a blue print could be made with these additions and corrections, making it possible to always have an up-to-date map of the entire distribution system which could be distributed to the different departments.

(2) A careful load test should be made on each transformer, primary circuit and branch feeder to determine the approximate load being carried compared to the size of copper used.

(3) A voltage survey should be made at different parts of the line by means of graphic voltmeters in order to determine the voltage regulations on each feeder between no-load and full-load conditions, and thereby be able to correct any poor voltage condition existing on the present feeders.

(4) Having all this information and a map of the entire distribution system the operator can then carefully study the existing conditions at each section of the line, and with this knowledge be able to intelligently lay out an ideal distribution system to fit future requirements for a period of possibly five years.

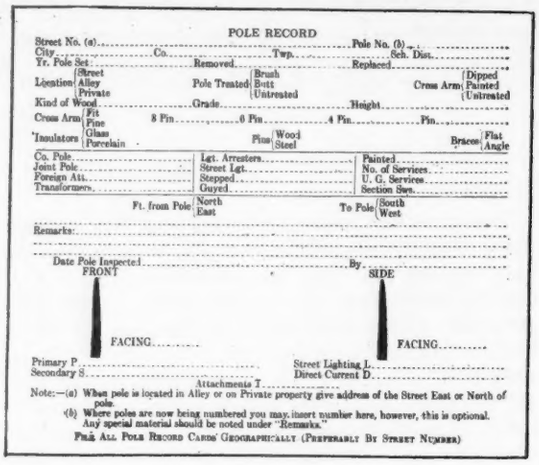
(5) After making a definite layout of what is considered an ideal system, then the plan would be that whenever any construction or maintenance work was done, that it conform as closely as possible to that of the proposed layout. In this manner it would not take long before the distribution system would be entirely rebuilt in accordance with good practice.

Primary Distribution Centers Should Be Established.

In the planning of any feeder the question of the proper size of copper wire is not usually given sufficient attention, with the result that it is not long until a circuit is badly overloaded so that it is impossible to maintain the proper voltage. For this reason it is most essential to know the character of load to be connected to a given circuit before the size of wire to be used can be determined.

In order to successfully maintain a uniform voltage on any circuit consideration should be given to see that customers are not connected the entire length of a long heavily loaded feeder, as this means that there will be a considerable difference in voltage received by the customer nearest the plant and the one farthest away. At times of heavy load the customer nearest the plant will get several volts more than he should, while the one farthest away will get several volts less than required. This difficulty is largely overcome if a center of distribution for a section which is to be fed by a given feeder is selected, and then let the main feeder come direct from the power house to the center of distribution without taking off any load. Branch primaries can then be extended in each direction from the distribution center.

Having established this center of distribution the drop in the feeder from the plant or substation to this distribution center is of less importance so long as the voltage is regulated to give the correct voltage at the center of distribution. The distance of customers from this point will be relatively short and the voltage drop will not be objectionable.


POLE RECORD

Street No. (a)..... Pole No. (b)....

City..... Co..... Twp..... Sch. Dist.....

Yr. Pole Set:..... Removed..... Replaced.....

Location {Street / Alley / Private} Pole Treated {Butt / Brush / Untreated} Cross Arm {Painted / Dipped / Untreated}

Kind of Wood..... Grade..... Height.....

Cross Arm {Fir / Pine / Oak} 8 Pin..... 6 Pin..... 4 Pin..... Pin.....

Insulators {Glass / Porcelain} Pins {Wood / Steel} Braces {Flat / Angle}

Co. Pole..... Lgt. Arresters..... Painted.....

Joint Pole..... Street Lgt..... No. of Services.....

Foreign Att..... Stepped..... U. G. Services.....

Transformers..... Guyed..... Section Ser.....

Ft. from Pole {North / East} To Pole {South / West}

Remarks:.....

Date Pole Inspected..... By.....

FRONT SIDE

FACING..... FACING.....

Primary P..... Street Lighting L.....

Secondary S..... Direct Current D.....

Attachments T.....

Note:—(a) When pole is located in Alley or on Private property give address of the Street East or North of pole.

(b) Where poles are now being numbered you may insert number here, however, this is optional. Any special material should be noted under "Remarks."

File All Pole Record Cards Geographically (Preferably By Street Number)

Fig. 1.

Problems in Successful Operation of Secondary Networks.

The fact that a voltage drop of 2% below the rating of a tungsten lamp causes the loss in revenue of 5%, as well as the fact that the customer loses 7% in illumination, brings out the importance of maintaining good voltage regulation on lighting circuits both as a means of increasing the revenue and giving better service. The usual practice is to allow a drop of 2 volts from the transformer to the house entrance, and 1 volt drop in house wiring. Thus a transformer voltage of 118 will supply the proper voltage for 115-volt lamps at the lamp socket.

One of the objects of this paper is to discuss the advantage of banking transformers into a secondary network, and from the above it is evident that a great deal of time and thought should be given to the proper laying out of a secondary distribution system. The first essential is an accurate map of the existing distribution system showing the size of transformers, their locations and the loads they carry, as shown by tests with a split-coil current-testing transformer. The distribution map which gives a perspective of the entire system will show at a glance where transformers can be eliminated or the location of others changed so as to make possible the elimination of some of them. With this information an intelligent layout of an ideal secondary network can be made with the result that considerable transformer capacity may be saved and improvement of service made. A few of the advantages of secondary network over that of the individual transformer installation are enumerated as follows:

(1) It permits the use of a few large transformers instead of a large number of small ones, and the iron loss per kilovolt-ampere of capacity being less for large transformers than for small ones the total transformer iron loss will be reduced even though the total transformer capacity is the same.

(2) Large transformers cost less per kilovolt-ampere of capacity and hence the investment charge, even though the total capacity is the same as for a large number of small ones, will be reduced.

(3) By taking full advantage of the diversity factor the total kilovolt-ampere transformer capacity is materially reduced, thereby reducing the iron loss.

(4) For the same reason the investment charge is reduced and the principle is the same as when the station generators are operated in parallel.

(5) Reduced resistance loss is secured for equal copper investment because the maximum demands do not occur on the same section of secondary at the same time.

(6) The energy saving due to distributing at 230 volts (three-wire) instead of 115 volts (two-wire) makes possible the distribution over a given area with the same copper and much smaller resistance loss.

(7) Better voltage regulation is secured because each customer is served from two or more directions.

(8) Better continuity of service because each customer is served from two or more transformers.

For the successful operation of a secondary network it is important that each transformer be sectionalized from the other by means of a secondary sectionalizing switch, which should be located at approximately the neutral-load point between any two or more transformers. There has recently been developed a very satisfactory secondary sectionalizing switch for this purpose that may be cut into the secondary feeders at some neutral-load point between the transformers. Caution, however, should be exercised not to insert a sectionalizing switch in the grounded neutral wire of a transformer secondary since it is evident from experience what the result would be in case the neutral fuse should blow. In the event

TRANSFORMER RECORD. No.....

Date Purch..... Prim. Volt..... Taps.....
Make..... Sec. Volt..... Mfg. No.....
Type & Form..... Frequency..... Size K. V. A.....
Date Cond..... Entered by..... Folio..... Cost.....

Date Set	Date Removed	Circuit	Date Oil Insp.	No. Trans. in Bank	Test Data					Location and Remarks
					Date	Volt	K. V. A. Load	Copper Loss	Core Loss	

Fig. 2.

of failure of any transformer primary fuse, the secondary sectionalizing switches will immediately, upon overloading, disconnect this transformer from service, and only that section within the radius of this transformer will be inconvenienced by an interruption of service. By encouraging the customers to immediately report any interruption to service or any dimness to lamps the trouble man can be dispatched to this point and have no difficulty whatever in locating the trouble; by this means considerable time would be saved in shortening the period of interruption.

In banking together transformers care should be taken to see that transformers of the same make, type and ratio are banked together. The reasons for this are evident. If the characteristics of two banked transformers are not the same or nearly so they will not divide the load properly.

Protection and Maintenance of Transformer Installations.

Previous to 1909 there had not been developed the present grade of silicon steel for transformer cores. The result was that the cores of transformers manufactured before that date aged quickly, especially when subjected to heavy loads, the core loss increasing quite rapidly. The amount of this core loss may even make it profitable to take down some of these transformers and junk them, but before this is done they should be taken down, cleaned and given a core-loss test. If a flat-rate circuit is in operation it may be possible to use these transformers for this service as the circuit will be in use only a few hours each day and the core loss would be of less importance considering the short time they are used.

Transformer oil serves a vital purpose in the life of a transformer. It acts as a heat conducting medium to transfer the heat from the core and coils to the case where it is dissipated by the circulation of air about the transformer. It preserves the insulation and frequently restores the insulation after a breakdown. If the oil forms a hard coating on the coils or gets thick and will not circulate freely the transformer should be cleaned and filled with new oil. Moisture in oil will quickly cause burnouts and the loss of transformers. A periodic inspection of the condition and amount of oil in each transformer will show up these difficulties, and then if immediate steps are taken to remedy them considerable trouble and loss may be averted.

Standard line transformers will safely carry 50% overload for several hours. It is therefore a great saving in transformer capacity and core loss to let lighting transformers operate at as high as 50% overload during the short-hour winter peak. This materially reduces the necessary investment in transformers without danger of burning out this equipment.

As for the protection of transformers against lightning it has been found that greater protection is afforded a transformer the closer the lightning arrester is located to the transformer, and as far as possible it is therefore desirable to locate the lightning arresters on the same pole with the transformer. The reason is that the lightning disturbances often are of such high frequency or of impulsive suddenness as to have the voltage stress concentrated in a short length of line, and in the extreme case, a few hundred feet from a lightning arrester, destructive voltage may be produced by lightning before the lightning discharge is relieved over the lightning arrester to ground. As it is impractical to connect the lightning-arrester ground with the secondary neutral ground it is recommended that the ground wire for the lightning arrester be installed on the same

pole with the transformer. Proper protection, however, being made from accidental contact with the lightning arrester ground wires by means of wooden moulding.

Requirements in Connection With Grounded Secondary Circuits.

The consensus of opinion is now very much agreed as to the advisability of grounding the secondary of the transformer at the pole as well as the house-entrance switch. The advantage to be gained by this practice is the protection of the customer and his wiring installation as well as the lineman from coming in contact with a high-voltage circuit that might accidentally become crossed with the secondaries. Also the protection of line equipment from such high voltage occurring between the primary and secondary winding of the transformer.

In the grounding of the transformer secondary there are three requirements that are most important:

(1) The ground wire must be permanently and well grounded to insure it protecting the apparatus for which it is intended. It would be well before connecting a ground wire to either a lightning arrester or secondary neutral for the lineman to test the value of this ground connection.

(2) A ground wire of very low resistance is important in order to protect the house circuits from high voltage due to crosses with the primary circuits, the possibility of a lightning surge, or the result of a breakdown between the primary and secondary windings of a transformer.

(3) The ground wire should be so installed as to reduce the reactance of the circuit to a minimum, thereby protecting the house circuits and transformers from lightning disturbances.

Wherever it is possible to attach a ground wire to a water system this should be done, as this insures both a permanent and low-resistance ground. As this is not always convenient the next solution is to drive an 8 or 10-ft. length of ¾-in. galvanized-iron pipe into the ground at the base of the pole.

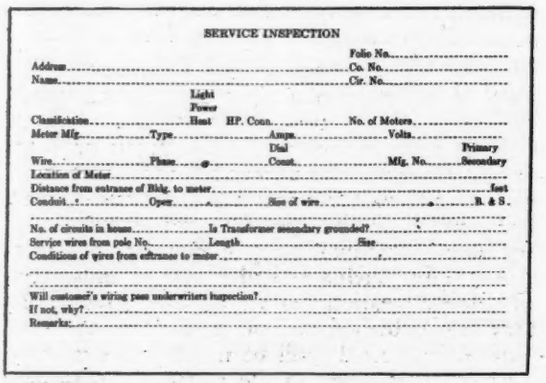
It is generally considered that a ground connection of 20 ohms resistance or less is satisfactory, and therefore it is recommended to use either a No. 6 or No. 4 B. & S. copper wire for the ground. The reason for copper in preference to galvanized iron is the difference in resistance of the two metals and the possibility of the latter corroding at the ground line.

As experience has proven that a lightning arrester for the protection of the transformer should be located on the same pole with the transformer, and for the fact that it is undesirable to connect the lightning arrester ground to the same ground wire as that of the secondary neutral, it is suggested that the secondary neutral ground wire be located on the pole adjacent to the transformer, and be properly protected from accidental contact by means of wood molding.

As there is always a possibility of a ground wire failing to perform good service due to changing climatic conditions it is highly recommended that some form of regulations be outlined whereby the local electrician be required to make a permanent ground connection at or near the entrance switch, so that the grounded neutral wire at the pole may also be grounded at the house entrance. If this house ground connection is attached to a water pipe, care should be taken to see that it is made on the service side of the watermeter and stockcock.

Periodic Inspection of Distribution Systems for Maintenance.

It is evident that sufficient attention has not been given by operators to the proper maintenance of distribution systems, leaving the matter of what should be reported entirely to the line foreman rather than knowing the condition of the system as a whole themselves. Feeling that no distribution system can operate perpetually without receiving proper attention, the question then resolves itself as to how a reconstruction program can be arranged to take care of regular maintenance work. As a suggestion at this point it has been found from inspection trips that if when minor defects occur they are given immediate attention it probably prevents serious interruptions to service, and it is an accumulation of these small minor defects that really make the maintenance work of distribution systems expensive. As a suggestion along this line it is found to be an excellent plan to take two linemen and possibly a groundman, together with a conveyance, and have them systematically proceed periodically over the entire distribution system and where a crossarm is rotted, a pole raked over, an insulator broken, a tie-wire loose, a cross in the service line, a house bracket off, etc., for them to immediately repair these defects. By this



SERVICE INSPECTION

Folio No.....
Address.....Co. No.....
Name.....Cir. No.....

Light
Power
Classification.....Heat HP. Conn.....No. of Motors.....
Meter Mfg.....Type.....Amps.....Volts.....
Dial Primary
Wire.....Phase.....Const.....Mfg. No.....Secondary
Location of Meter.....
Distance from entrance of Bldg. to meter.....feet
Conduit.....Open.....Size of wire.....B. & S.

No. of circuits in house.....Is Transformer secondary grounded?.....
Service wires from pole No.....Length.....Size.....
Conditions of wires from entrance to meter.....

Will customer's wiring pass underwriters inspection?.....
If not, why?.....
Remarks:.....

Fig. 3.

means the cost of minor maintenance work is considerably reduced, as well as the elimination of a defect that would be likely to cause future line trouble.

In connection with this inspection and minor maintenance of distribution systems, if a periodic inspection is made of the entire system, including distribution lines, as well as service and meter installations, the efficiency of any system will be improved and unnecessary line losses eliminated.

Methods of Keeping Records for Distribution Systems.

In compiling records of distribution systems it appears that the practice is to go from one extreme to the other. Either the matter of records is taken up so elaborately that the cost of the clerical help is excessive and the information tab-

ulated of little value to the men actually doing the work, or else to the opposite extreme of not keeping any records is pursued, both of which reflect on the efficient operation of a property. In order to minimize the amount of clerical work necessary to maintain adequate records of a distribution system the following appears to be essential for the average property. Of course, these records would have to be elaborated upon, depending upon the size of the property and the amount of detail required.

Essential Records for Average System.

For filing purposes it is essential that all record cards should be of the same dimension, and a card 4 by 6 ins. appears to be very practical and of adequate size to contain all the desired information.

Considerable discussion has always been raised as to the desirability of numbering poles consecutively, and while this opinion may be correct in regard to properties of large size, it is not believed that for the amount of work entailed and the cost of numbering poles some dividing line should be determined as to what size a town should be to warrant the numbering of poles. In this discussion it is assumed that poles in towns of 100,000 inhabitants or larger should be numbered in some systematic order.

In those cases where poles are not numbered an excellent plan would be to maintain a record of each pole, but instead of filing these cards according to the pole number they should be filed geographically in a manner similar to the arrangement of the customer ledger, that is, the pole-record card would be given the address of the house located nearest it. Where a pole is located in an alley then it can be designated by giving it the geographical location of the house on either the north or east side of the alley, or the address of the street on the south or west side of the alley. In this manner there would be no confusion where there is a pole line located in the alleys on both sides of a given street.

In order to eliminate any duplication of work in maintaining such a record it is most important that all information pertaining to a given pole should be embodied on one card, such as illustrated in Fig. 1. It will be noted that consideration has been given to the matter of taxation, as experience has shown that without this data it is likely several different taxes will be paid on the same property; whereas, if it is exactly known where the property begins and ends for each of the city, county, township and school districts, then this information will be valuable in connection with assessments and payments of taxes.

In order to obtain information pertaining to the life of different poles under certain climatic conditions, and also of what value the different methods of treatment have upon the life of poles it is important that some record be kept in order to learn definitely the results that may be expected from certain pole treatments.

It is also of value in the making of an inspection of lines to know the type of construction as well as the different attachments that are made to the poles. This information, together with the condition of the pole, can be noted on the pole record card.

As it is most important to know the size, voltage, type and ratio of transformers on lines, as well as the load and voltage conditions of each transformer, it is then necessary to compile some record on each of the transformers.

As the core loss, copper loss and regulation characteristics vary, depending upon the improvements made by the manufacturer, it is found to be a good plan to arrange the transformer list

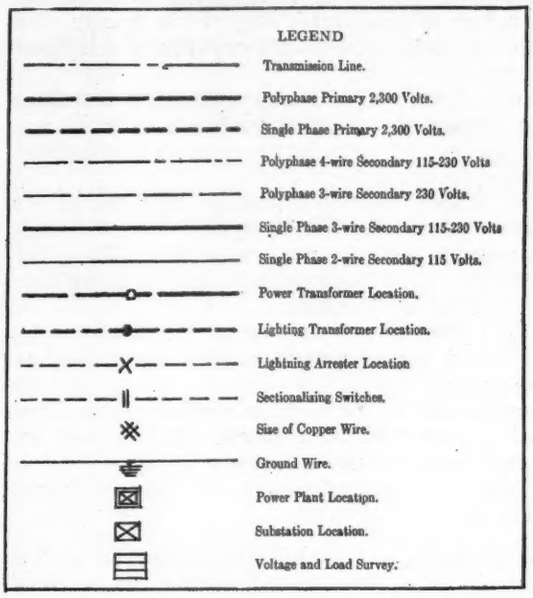


Fig. 4.

chronologically according to the year each transformer was manufactured, and then to number the transformers consecutively in accordance with this list.

Due to the lack of attention given 2300-volt distribution transformers it is found that a careful periodic inspection will bring to light many conditions which if not attended to immediately will cause interruptions to service and possibly burned-out transformers. For this reason it is important that careful inspections be made of each transformer and its condition noted on its respective card.

Service and Meter Loop Installations.

It is surprising to note the lack of attention that has been given to the condition of the service-loop and meter installations connected to secondary distribution systems, and after obtaining a slight idea of the amount of energy being lost or unpaid for on account of these conditions the writer was prompted to prepare the attached service inspection card with the idea of making a careful periodic inspection of every service from the point of contact on the distribution system to the service side of the watt-hour meter.

In the preparation of a map showing the distribution system as one complete unit, a great many different methods have been followed, and with but few exceptions have been found too elaborate and expensive to maintain. Following are a few suggestions which appear to be essential in order that such a map may be of the most value:

(1) The legend to be used should be such as to be very easily understood by the average workman.

(2) The legend should be so arranged that

by the progressive stages of line construction it would not be necessary to erase any more of the present system to illustrate the changes than absolutely necessary. That is, by changing a single-phase primary circuit to a polyphase circuit, or the changing of a two-wire to a three-wire secondary, it would only be necessary to rule a heavier line over the present circuit. Then by indicating transformers, lightning arresters, and switches on the reverse side of the tracing these can be changed without marring the present layout.

(3) A copy of the map embodying the different circuits should be in the hands of every man having to work or refer to any part of the distribution system.

(4) Some method should be followed, after a survey of the distribution system has been made, in order to keep the map up to date. These corrections can be made to the original tracing from the regular work orders.

(5) The map should be on a scale so as not to crowd the circuits to a point where they are congested, but so the circuits are easily distinguishable to the average workman. In larger cities it may be an excellent plan to have sectional maps, while in towns of 30,000 to 40,000 a map of a scale of 500 ft. to 1 in. would probably be more adaptable.

Legitimate and Illegitimate Losses of Distribution Systems.

In view of the fact that central-station companies are endeavoring to obtain the maximum efficiency from the operation of their properties it does not appear to be amiss at this time to mention some of the losses that are constantly occurring in the distribution of electrical energy that may be classed as legitimate and illegitimate losses. In the generation and distribution of electrical energy there are some losses such as copper losses, transformer losses and conversion losses that cannot be entirely eliminated, but there are many other losses that are illegitimate that may be overcome to the greater efficiency of the system. In order to determine what losses are justifiable it is quite necessary to make a careful survey of the entire system after which the problem may be considered as being divided into five parts.

(1) Determination of how much of the loss is legitimate and how much is illegitimate.

(2) To locate and correct the cause of these illegitimate losses and guard against the recurrence of this cause.

(3) To furnish information whereby legitimate losses may be reduced by changes in operating practice and physical condition.

(4) To see that rate schedules are properly applied so that correct revenue is received for energy delivered; also to see that billing departments are furnished necessary data for correct billing.

(5) To furnish statistical information for use in constructing more equitable rates.

Methods of Reducing Legitimate Distribution System Losses.

Although it is possible to reduce the amount of legitimate losses on a distribution system, still there is a point beyond which it is unprofitable to go, due to the relatively small savings made possible. The losses that cannot be entirely eliminated but can be improved are as follows: Distribution copper losses, transformer copper losses, transformer core losses, conversion losses, and meter shunt losses.

Distribution copper losses can be reduced to a minimum by installing copper wire of sufficient capacity to carry the current transmitted. There is a point, however, in the size of copper where it is unprofitable to increase the size of wire in order to make a saving of the I^2R loss. It is only possible to make an estimate of this loss after making a careful load and voltage survey of the system.

The transformer copper losses are practically set, depending upon the load carried on each transformer. Having a 24-hr. load curve on the operation of a transformer it is possible to estimate this loss.

Transformer core losses can be improved considerably by installing a transformer of sufficient kilovolt-ampere capacity to replace several smaller transformers. The core loss per kilovolt-ampere of capacity decreases quite rapidly with the increased size of the transformer, and the type of iron used in assembling the core has a marked influence on the losses.

The conversion losses may be reduced considerably where a small direct-current load is supplied on an over-capacity unit.

Meter shunt losses are constant and can be estimated by tabulating the sizes, types and makes of different watt-hour meters.

Illegitimate Distribution Losses That Can Be Reduced.

The following list includes a few of illegitimate losses that should be given immediate attention with the object in view of reducing them to a minimum: Stolen current, low voltage, customers removing the primary fuse from a potential transformer, overloading instrument transformers, secondary wires crossed, lack of control on flat-rate circuits, inaccurate meters, primary wires coming in contact with trees, and lack of proper maintenance.

As for the inaccuracy of watt-hour meters it is generally agreed that some periodic test should be made, and therefore, the meter department should be developed to a high state of efficiency to carry on this work. Since it is through meters that the greatest part of revenue is obtained, it becomes essential that regular and systematic steps be taken to maintain their accuracy. It naturally follows that the frequency of such tests will depend largely upon the revenue derived from the particular meter. In some states legislation is in effect which specifically states the period of tests. In any event a test schedule should be developed taking into account the revenue earned and revolutions of the meter, rather than merely the size of the meter. Direct-current meters usually require more frequent testing than alternating-current meters.

The following is a meter-test schedule based upon the monthly revenue derived from a particular meter: Up to $5 per month revenue, test every 36 months; $5 to $10, test every 24 months; $10 to $100, test every 12 months; $100 to $500, test every 6 months, and $500 or over, test every 3 months.

Automatic Controllers for Direct-Current Motors

Seventh of a Series of Articles on Principles and Application of Motor-Control Apparatus — Discussion of Time-Limit Starting Controllers—Operation of Dashpot and Motor-Operated Types

By G. J. KIRKGASSER and E. W. SEEGER

Classes of Automatic Starting Controllers.—There are two broad classes of automatic starting controllers: time-limit and current-limit. The former operate on the principle of accelerating the motor from rest to full speed in a definite period of time, while current-limit starting controllers limit the armature current during the starting period, the rate of acceleration depending on the motor load.

Time-Limit Automatic Starting Controllers.—These controllers are designed to operate independent of the load on the motor. If the motor is so heavily loaded that it will not start on the first point the controller will continue to function until a point is reached where the motor will start or a fuse blows or a circuit-breaker trips. They are practically independent of fluctuations in line voltage and can be relied upon to gradually accelerate the motor under any reasonable load conditions.

A sufficient time interval must be provided in order to properly bring the motor up to speed when fully loaded. On light loads, however, more time is taken to accelerate the motor than is actually required, and in some cases this is an objectionable feature.

Dashpot Type of Time-Limit Controllers.—The most common time-limit starting controllers are those in which the time interval is obtained by the use of dashpots. The controller illustrated in Fig. 39 is an example of this construction.

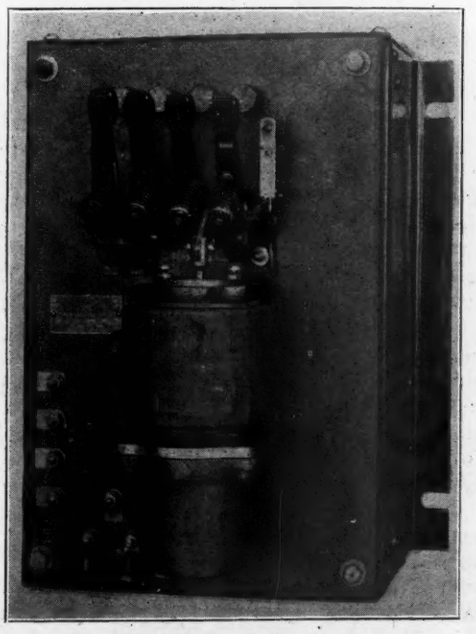


Fig. 39.
Direct-current automatic starting controller of the multiple-finger type, with dashpot retardation.

A solenoid causes a plunger to close four fingers to make successive contacts with four stationary buttons, and this action results in shunting one step of resistance after another. The dashpot below the solenoid prevents it from drawing up the plunger too rapidly, which would result in having the fingers operate to shunt the resistance out of circuit before the motor had accelerated properly. An adjustment screw, shown in the illustration, is used for varying the rate of finger operation. When the control circuit to the solenoid is closed the motor is started and acceleration takes place automatically. The control may be operated from push-button stations, float switches or pressure regulators. Fig. 40 shows the connections.

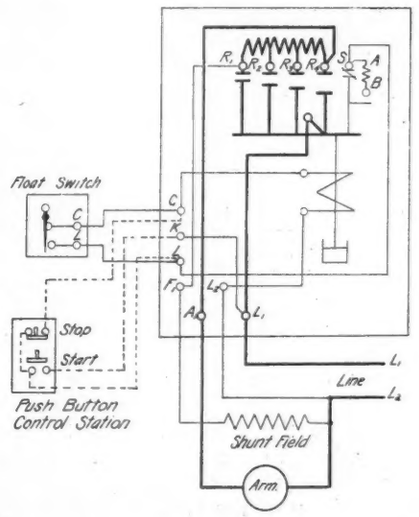


Fig. 40.
Diagram of connections for controller shown in Fig. 39.

Operation of Dashpot-Type Time-Limit Controllers.—When the control circuit of the solenoid-operated multiple-finger controller is closed, for example, by means of a remote-control switch, a circuit is completed from the line, L_1, through the protective resistance switch (which is explained in the following paragraph) to the point L, through the pilot device to the point C, to the solenoid and then back to the line, L_2. The solenoid plunger is drawn up and revolves the shaft carrying the contact fingers, closing the first finger at R_1. The circuit is then com-

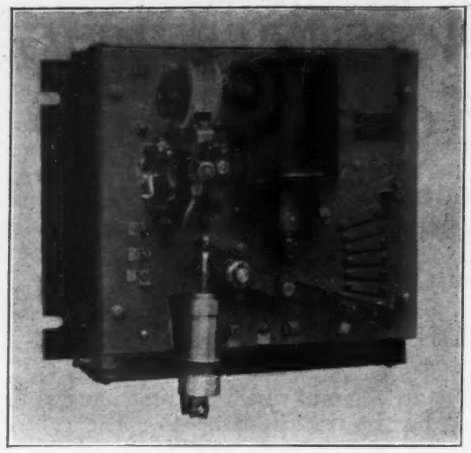


Fig. 41.
Time-limit starting controller of the pivoted-arm type, with dashpot retardation.

pleted through the resistor steps R_1R_2, R_2R_3 and R_3R_4 to the motor armature, which begins to rotate. The design is such that the fingers do not all make contact at one time. As the plunger is drawn up by the solenoid its motion is retarded by the dashpot below. This causes the shaft carrying the fingers to move slowly, closing the fingers in succession. When the second finger makes contact, resistor R_1R_2 is shunted out of circuit and the circuit includes only the two remaining resistors, R_2R_3 and R_3R_4. When the third finger makes contact R_3R_4 only is in circuit, and the closing of the fourth finger connects the motor directly to the line.

The small "flipper" switch S is closed until the solenoid plunger is in the extreme "up" position, when it is tripped open and inserts the resistance AB in the solenoid circuit. This resistance is added to the circuit to keep the current down to a value sufficient to maintain the "full on" position of the controller without overheating the solenoid.

Control of Dashpot-Type Time-Limit Starting Controllers.—If in place of a single float-switch it is desired to start the motor with a switch at one location and stop it either from that same control switch or from others at several different points, single-pole float-switches must be replaced by three and four-way switches.

Momentary-contact push-button switches are also used for remote control in some cases, the connections for this type of control being shown

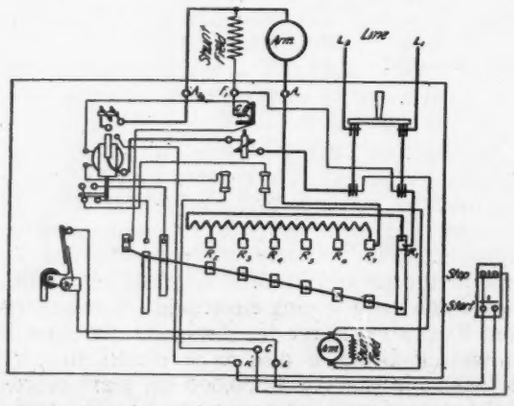


Fig. 42.
Diagram of connections for a motor-operated automatic starting controller.

by the dotted lines in Fig. 40. The motor is placed in operation when the "start" button is depressed and continues to run until the "stop" button is depressed or until the power supply fails. On the return of power after a failure the motor cannot be again started until the "start" button is depressed.

If a pump is driven by the motor and a float in a tank is used in connection with a single-pole float-switch, the latter is connected as shown in Fig. 40. When the float-switch closes the solenoid is energized and the motor is started.

When operating on a compressor a pressure-regulator switch is employed, which opens or closes according to limits of pressure, and makes or breaks the circuit to the solenoid of the automatic controller, thus starting or stopping the motor.

A variation of the type just described is the pivoted-arm time-limit starting controller, illus-

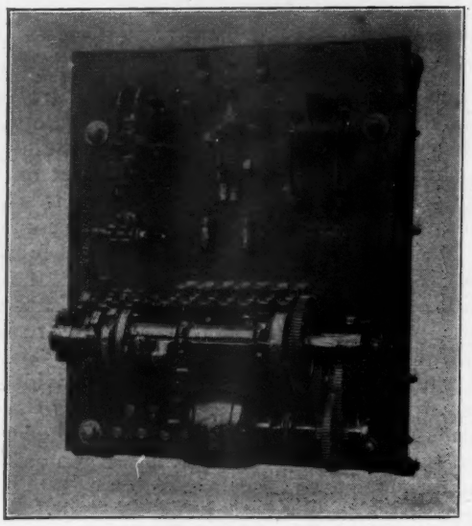


Fig. 43.
Motor-operated non-reverse automatic starting controller for 25-hp. motor.

trated by Fig. 41. The solenoid operates a sliding arm over successive contact segments to which resistances are connected back of the slate front. Further discussion of this type will be made in connection with data on controllers for pumps and compressors.

Types of Dashpots for Automatic Controllers.—Dashpots may be of either the air or oil type. In the air type a partial vacuum is created as the piston is raised, and the rate of acceleration can be varied by adjusting the size of the opening through which air is admitted to the cylinder of the dashpot. In an oil dashpot the timing is usually obtained by forcing the oil from one side of the piston to the other through an adjustable valve placed either in the piston itself or on the dashpot frame.

Difficulty is sometimes experienced with the air dashpot in dusty places, due to dirt being drawn into the valve, in this way affecting the time setting. Trouble is also experienced if the piston is not properly oiled. Air dashpots will, however, usually be satisfactory if properly cared for. Oil dashpots are, in general, more satisfactory than the air type. If the proper kind of oil is used there will be practically no variation

in timing even over a wide range in temperature.

Time-limit starting controllers of the dashpot type are in common use with motors of less than 25-hp. capacity, although in the larger sizes a magnetic main switch is used for making and

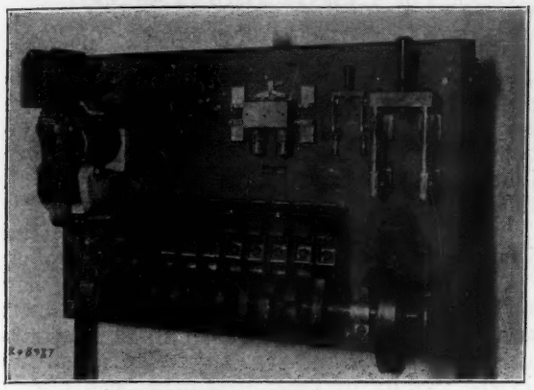


Fig. 44.
Front view of Westinghouse motor-operated automatic time-limit starting controller.

breaking the circuit, the dashpot merely operating the lever for the contact fingers. For still larger sizes a dashpot relay can be used similar to the automatic controller shown in Fig. 39. In this case the fingers and contact segments control magnetic switches which in turn shunt resistance out of the motor circuit.

Dashpots are rarely used when it is desirable to have a starting interval exceeding 30 seconds.

Motor-Operated Time-Limit Starting Controllers.—Time-limit acceleration is sometimes obtained by using a small motor connected through gearing to a drum cylinder or to a camshaft which operates individual switches. The timing in this case depends upon the speed of the motor and is independent of temperature. The speed of the timing motor can, of course, be adjusted by varying the resistance in either the armature or field circuit. It is possible to obtain any desired timing with this type of control.

Fig. 42 shows the connections of a motor-

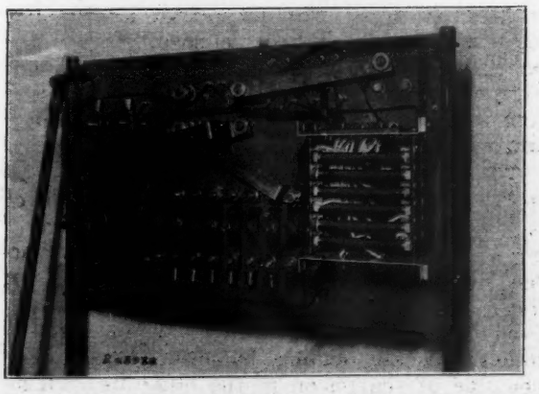


Fig. 45.
Rear view of controller, illustrated in Fig. 44, showing location of the pilot motor.

operated time-limit starting controller and Fig. 43 is an illustration of the same equipment.

Other Methods of Timing Starting Controllers.—Other methods such as those employing wattmeters and clock movements are used when a long starting interval is desirable, but these methods are seldom required.

(To Be Continued.)

ELECTRICAL CONSTRUCTION DEVELOPMENTS IN SOUTH AMERICA.

Hydroelectric and Steam Power Being Developed in Many Places for Railway, Industrial, Mining and Domestic Service.

The countries of South America possess vast resources for the development of hydroelectric power. In support of such a development efforts are being made to cheapen the cost of fuel for transportation and other purposes, coal being not only high priced but difficult to obtain. Efforts are also being made to extend railways so that interior sections may be made accessible.

In Argentina, the Iguazu of the northeastern corner of the country and the great group of water powers in northwestern Patagonia, Neuquen, Rio Negro and Chubut are capable of producing enormous quantities of hydroelectric power. Due to their remote locations, they have attracted less attention than the limited resources of Cordoba, Tucuman and Mendoza.

The falls of the Iguazu afford the best single resource in Argentina and one of the best in the world. Accordingly, the Argentine government has inaugurated a survey preliminary to the construction of a power plant there. It is reported that an international power plant, with a capacity of 150,000 hp., will be erected jointly by Argentina, Uruguay and Brazil. At present, La Compania Hidroelectrica de Tucuman (English) is the only power plant established in Argentina. La Empresa de Luz y Fuerza (German) has a concession for the construction of a power plant at Mendoza, work on which was begun several years ago, but indefinitely suspended because of a dispute over the concession. The municipality of Mendoza is to construct a power station at the falls of the Rio Blanco and to build an extension tunnel and aqueduct system costing $5,600,000.

Extensive Railway Electrification Planned in Argentina.

Dr. Julius Klein, the United States commercial attache to the Argentine Republic, says that power plants could well be established near Salta near Iguazu and in the Rio Negro district to serve Bahia Blanca. He says also that there will be a great demand for power for the various railroads which contemplate the electrification of their lines. At the present time the railways use three-fourths of the coal consumed in Argentina.

Brazil has extensive plans for the development of interior transportation, including the construction of power plants for industries and for the electrification of railways. Last August the government asked for bids for the erection of a 30,000-hp. plant on the river Jacuhy. The concession is for 30 years, at the expiration of which time the state will take over the installations. La Empresa Electrica de Jundiahy and the Sao Paulo Electric Co. have 10-year contracts for furnishing 8,400,000 kw-hrs. for the Paulista railway, which is now being electrified. The government line from Barra to Pirahy of the Central Railway of Brazil is also to be electrified. Rio de Janeiro is to have a 270,000-hp. plant erected in the near future by an internationally organized company having American interests. Two

hydroelectric stations are to be built and electric street-car service inaugurated in the vicinity of Rio de Janeiro.

The Itabira Iron Ore Co. recently secured a concession from the Brazilian government to construct and exploit high-temperature furnaces for steel products, reducing apparatus, etc., and plans to electrify the Victoria-Minas railway, for which a power plant will doubtless be constructed. An electric smelting plant, the first of its kind in South America, will be built in Ribeiro Preto, Province of Sao Paulo, by the Companhia Electrica Metallurgica Brazileira. The construction of the mill will be started as soon as the American contractors can get their engineers on the ground. The mill will be 75 mi. from the mines of iron ore in the Province of Minas Geraes.

Hydroelectric Resources of Bolivia to Be Developed.

Bolivia in its present stage of development is a country of mines, though other resources exist. There are only three or four towns of any importance and population, and the present field for street railroad and power transmission material is restricted. The greatest hydroelectric resources are those in the vicinity of La Paz, Tres Cruces and Colquechaca, and plans for their exploitation have been made. The three initial power plants will entail an expenditure of $10,000,000 and will require large quantities of other machinery and electrical accessories in addition.

The La Paz-Yungas electric railroad is now being constructed by the Bolivian government with funds largely raised through a $2,400,000 loan made in the United States a few years ago. This line and the Corocoro copper mines, whose directors are considering the electrification of the plant, and the city of La Paz itself, for lighting, heating, cooking and industrial purposes, will utilize power supplied from the Yungas river near La Paz.

The progressive mining section of Tres Cruces requires power and heat and needs two tramways operated by electricity to connect Oruro and Cochabamba. The Cochabamba-Valparaiso railroad needs capital to complete the electrification of its system and to reconstruct its lines to meter width. The wealthy mining district of Colquochaca lacks electric power and heat, and an extension of the railway to Uncia, another mining center, is urgently needed.

An electric line, controlled by local capital at Cochabamba, has been completed for upwards of 45 mi. and an additional 57 mi. is under construction. Electric lighting plants exist in about a dozen towns and tramways in three or four.

The Bolivian & General Enterprise Co. operates the tramways, electric lighting and telephone systems of La Paz, a city of 100,000 population, the capital of Bolivia. This company is owned almost entirely by the French munitions firm of Creusot & Schneider. The power is hydroelectric, and the tramway line which is approximately 3 mi. in length is operated with eight cars of American make. La Sociedad de Luz y Fuerza Electrica de Cochabamba, a local firm capitalized at $2,000,000, operates the previously mentioned interurban line terminating in Cochabamba and also furnishes light and power to the towns of Arami, Vinto, Puncta, Tarata and Cliza. The hydroelectric station on the Chocaya river supplies the power.

Sucre, the capital city, sadly lacks modern transportation facilities, a mule tramway still existing in this town of 23,000 persons. La Empresa de Luz y Fuerza Electrica de Sucre has a monopoly of the light and power supply of the city, and La Empresa de Luz y Fuerza de Oruro, a hydroelectric development, has lighting and power privileges. Tarija and Potosi have hydroelectric light and power, the former from Erquis, 6 mi. distant, and the latter from 32 reservoirs built by the Spaniards in the 16th century on the hills above the city.

Hydroelectric power is beginning to be utilized by the tin and copper mines of Bolivia. The Guggenheims of New York City have acquired rights to three tin mines in the department of La Paz, consisting of more than 4000 hectares. Water and power rights to six streams in the vicinity of the mines have been secured and a hydroelectric plant is to be built, but the site has not been decided on. The installation of a smelting plant run by electricity is under consideration, and the company plans to found a town below the mines and construct an electric tramway to it. The Bolivian government has been for some time contemplating the electrification of all railways, and has declared as public domain the waters of such rivers as are capable of being used for the development of power. The Jafe de la Seccion de Ferrocarriles del Ministerio de Fomento has charge of these projects.

Plans Made for Electrifying Mining Operations in Peru.

In Peru most of the important cities and towns have electric light and power systems. Tramway systems traverse the streets of Lima, Callao, and towns adjacent thereto and are also established at Arequipa. La Empresa de Telefonos Arequipa y Mollendo operate the local and long distance telephone system of Arequipa and surrounding district. Las Empresas Electricas Asociadas de Lima (Lima Light, Power & Tramways Co.) controlling electricity and gas franchises in and adjacent to Lima, as well as more than 86 mi. of tramway, is the most important public utility company in Peru. The Peruvian Telephone Co. furnishes the telephone service for Lima, Callao, and nearby places. La Sociedad Electrica de Arequipa, a local company, furnishes electricity for light and power to Arequipa, the metropolis of southern Peru and its environs. El Tranvia Electrico de Arequipa controls the traction service of that city, and W. R. Grace & Co. operates the line as agents for the bondholders syndicate.

Various sections of the Peruvian railways are being electrified as power for that purpose is provided, especially the interurban lines near Lima. The last division of the Southern Railway of Peru (from Mollendo to Arequipa, Puno, Cuzco and from Gaqui, beyond Lake Titicaca, to La Paz, Bolivia) is an electric line. The mines of Peru are beginning to appropriate the hydroelectric resources of the Peruvian Andes. The Cerro de Pasco Copper Co. of Cerro de Pasco, province of Junin, is now installing a large smelter at Oroya and providing modern housing and other facilities for its workingmen, all of

which will consume considerable electric power which is likewise being provided. A vanadium-ore reducing plant for the mines of Minasgra, Peru, is to be built at Jumasha by the Vanadium Corp. of America, of Pittsburgh, Pa. A 20,000-kw. hydroelectric plant to furnish power for treating the ore is to be constructed about 25 mi. from Jumasha.

In Ecuador public-utility development has been slow. In Quito, the capital, there is an electric tramway line installed by J. G. White & Co. This, together with the Quito Electric Lighting & Power Co. is owned by the Ecuadorian Corp., a British company. Guayaquil, the largest city and chief port, has two street-car lines and electric lighting. The municipality of Portoviejo is to erect an electric-light plant.

Progress Shown in Development of Chilean Water-Power Plants.

Chile has vast hydroelectric resources, which have been but slightly developed. German and British capital, chiefly, has been invested to provide public utilities in Chile. The most definite development project in Chile at the present time is that provided by a $35,000,000 loan by the Chilean government, $10,000,000 of which has been appropriated for the electrification of the railway from Santiago to Valparaiso, via Casablanca. The generating station is to be located on the Aconcagua river about 30 mi. from Llai-Llai. In fact, the Chilean government will electrify all the state railways. The plans are in charge of Senores Rafael Edwards, the electrical consulting engineer for the state railways, and Ricardo Solar, a civil and electrical engineer of prominence. Moreover, an internationally organized company (Anglo-Chileano-Americano) in Valparaiso plans to construct a 100,000-hp. plant for supplying electric lighting and power to that region.

The Antofogasta-La Paz railway, one of the largest in the nitrate region of northern Chile, is to electrify its lines at a cost of $7,500,000, which project will entail the erection of a power plant. Colombia with her abundant hydroelectric resources, with electric light and power plants representing an investment of about $1,000,000, and various electric and steam tramways, operated in the five chief cities, exhibits an attractive field for electric installations. Her cities are becoming modernized with the development of her industries, and her mineral resources are being exploited as never before. A power company in Zipaquira is to construct a new plant near the Neusa river. Irrigation interests in Tolima will construct several large locks at La Bolsa near Espinal to facilitate the installation of an electric plant to provide lighting for El Espinal, Guamo, and El Chicoral.

IOWA ENGINEERING SOCIETY WILL MEET IN DES MOINES.

The annual meeting of the Iowa Engineering Society will be held in Des Moines, Jan. 18-20, with headquarters at the Chamberlain Hotel. One of the features of the gathering will be the manufacturers' exhibits which will be located on the mezzanine floor of the hotel. The consolidation of the Iowa Engineering Society with the various city clubs is progressing rapidly, this consolidation being made possible by the adoption of a new constitution whereby various city clubs might come into the society as chapters of that organization. The various committees of the society have been active and it is expected that some excellent results will be shown in the reports. An invitation has been extended to the engineering profession to attend the meeting.

ORIGIN AND DEVELOPMENT OF RADIO SERVICE IN AMERICA.

World-Wide Communication Service Fostered by Manufacturers and the Navy Will Serve for Governmental and Commercial Purposes.

America's position in communicating with the outside world has been most unsatisfactory for years. Its news and commercial services, which are such important a factor in trade, are practically at the mercy of foreign countries. Rear

Rear Admiral Bullard and E. F. W. Alexanderson.

Admiral W. H. G. Bullard of the United States Navy foresaw the danger to America's commerce if foreign interests secured a hold on two new American inventions which have done much to revolutionize the radio system of the world—the Alexanderson high-frequency alternator and the Weagant static eliminator. In the spring of 1919 the British Marconi Co., then operating in this country as the American Marconi Co., placed a $5,000,000 order with the General Electric Co., holders of the patents and manufacturers of the Alexanderson alternator. However, that company decided to consult with the United States Government. The Navy had been in control of wireless communication, so the situation was explained to Secretary Daniels. Rear Admiral Bullard in company with Commander S. C. Hooper went to New York City to appear before a meet-

ing of the board of directors of the General Electric Co. They urged the company not to sell, although they had no alternative to offer, for the Navy was no longer in the commercial field and could not buy the machine. The British contract was refused and, on the suggestion of Admiral Bullard, the Radio Corp. of America was organized by General Electric interests, a strictly American concern backed by the country's financial interests and possessed of the patent rights to the Alexanderson alternator.

Attitude of Navy Influenced by Ownership of Operating Company.

It was pointed out to the officials of the General Electric Co. that as long as foreign interests maintained any control of wireless interests in the United States the Navy would have to take the same attitude as it had previously done and could lend no support to the suggested corporation. Therefore one of the first acts of this new company was to purchase the British holdings in the American Marconi Co. Then with the consent of the stockholders it absorbed the American Marconi Co., thus bringing radio activity in the United States under American management for the first time.

G. C. Corbaley, assistant to the president of the Seattle Chamber of Commerce, in speaking before the National Foreign Trade Convention at San Francisco on the dire needs of better foreign communications with particular reference to conditions on the Pacific coast, recently said:

"This intolerable condition must be corrected. We must have adequate communication facilities with the Orient or America and the Pacific will lose the business turned by the war.

"Wireless offers the first hope of relief. This is largely because of the basic change that is taking place in the world's wireless situation. To most of us wireless is a thing little understood. Even to experts that is largely true. In its early stages wireless made slow progress. This was largely because the Marconi company was not adequately financed and the big problems of wireless could not command the concentrated technical attention necessary to their solution.

"In 1919 the world's wireless system was revolutionized. This was largely because of two inventions. The Alexanderson alternator was perfected to send a continuous wave of oscillations upon which the message was imposed, thus taking the place of the intermittent sparks. The Weagant static eliminator was perfected to relieve wireless from the atmospheric disturbances that had rendered dependable service almost impossible.

"Both of these developments were perfected under the control of the General Electric Co. The British Marconi Co. naturally sought to continue its leadership in the wireless field by securing for itself the benefit of these revolutionary changes. Then took place an event that should be written deeply in the history of American commerce. Due to the fine patriotism of Admiral W. H. G. Bullard these inventions were saved for America and have been made the foundation for a world-wide American wireless service.

"Admiral Bullard is the man who has really built the communications service of the Navy. As a captain he originally organized that service, and under war-time strain he was returned to its command.

"Impressed with the necessity for a world-wide service owned by Americans and operated by Americans he went before the officers of the General Electric Co. and pleaded with them to hold these inventions and to make the wireless of the future an American institution.

"Admiral Bullard won his point. The General Electric Co. purchased the control of the American Marconi Co. and reorganized it as the Radio Corp. of America, with a provision in its laws that 80% of its stock must always be owned by Americans.

"The Radio Corp. of America is preparing to cover the world with a modern efficient wireless system. One of the first steps in this plan is to be a comprehensive solving of the communications problem of the Pacific as far as wireless can ever solve that problem. A great modern sending station is to be built on the Pacific Coast of the United States, able to send messages direct to receiving stations in the principal cities of Japan, China, the Philippines and the Straits settlements.

"A concession has been secured from China to permit the erection of a similar sending station near Shanghai strong enough to talk direct to Seattle, Portland, San Francisco or Los Angeles.

"When this system is fully in operation wireless messages can be filed in any large city in the United States, or in the Orient, can be relayed by wireless to the sending station on their side of the water, and then sent direct by wireless to the city of their destination.

"All of this sounds too perfect to be true. It is probably more perfect than it will be for many months to come, but I have tried to give you the idea that has been approved by the General Electric Co. and that is in process of realization by E. J. Nally and his associates."

It was about 22 years ago that Admiral Bullard was first attracted by wireless work. During his student days at Annapolis electricity and electrical engineering had interested him. These studies he carried on following graduation and soon became known as one of the electrical experts of the navy. Wireless work appealed to him both as an electrical engineer and as a military officer. With his knowledge of electricity the military possibilities that lay in wireless were readily apparent. He is now director of the Navy communications service and was the first superintendent of radio service from 1912 to 1916, since enlarged to embrace all forms of communication activities.

Marconi Equipment Brought to This Country in 1899.

In 1899 Marconi brought to this country from Italy three sets of his new wireless apparatus, the immediate purpose being to use them in reporting the International yacht races that year. The Navy department appointed a commission to observe and report on the working of the system and following the report of this body, the Navy placed the battleship *Massachusetts,* the armored cruiser *New York,* and the torpedo boat *Porter* at the disposal of Marconi for further experiments. A shore station was established near New York City, the first in America. The three vessels were the first in the Navy so equipped, and thus the beginning of the Navy radio service.

The growth and development has been remarkable. No part of the Atlantic or Pacific is too far away to be out of reach of a radiogram from an American naval station. In fact, it has been possible for the United States Government to keep in constant communication with its forces abroad through radio from the New Brunswick station equipped with the Alexanderson high-frequency alternator.

OFFICERS ELECTED BY ELECTRICAL CREDIT ASSOCIATION.

The governing board of the New York Electrical Credit Association at its organization meeting Dec. 29 elected the following officers for 1921: President, William R. Conklin, American Copper Products Co.; vice-president, F. A. Booth, Westinghouse Electric & Manufacturing Co.; treasurer, A. F. Thacher, Alpha Electric Co., and secretary, W. W. Kreger. For the ensuing year the office of the secretary will be located at 47 West 34th street, New York City.

EDITORIAL COMMENT

Making National Parks Useful

The bill creating a Federal Water Power Commission which was passed by Congress last June gave the commission power to lease water powers existing upon and passing through national parks. Another bill is now in preparation for the purpose of obtaining permission to dam the waters of Yellowstone Lake. Already applications have been made to the Water Power Commission for concessions involving dams, power houses and transmission lines in the Grand Canyon and Sequoia National Parks.

Much opposition is being presented against these developments by daily newspapers and by the National Parks Association. That opposition should develop was to be expected, and at first light such opposition seems well taken and therefore justified. However, those who are familiar with hydroelectric developments cannot but feel convinced that needless alarm is being created.

In a bulletin recently issued by the National Parks Association the following warning is issued: "If Congress grants one single irrigation privilege in any national park, no matter how inconspicuous the dam or how little it injures the park, it destroys the historic principle of complete conservation which alone differentiates national parks from national forests. It opens the door. Entire commercialism of all national parks will follow logically and inevitably." The public is petitioned to write representatives in Congress asking that they keep commercial exploiters out of the national parks.

A bill permitting the irrigation reservoirs in the Fall River basin of Yellowstone Park passed the Senate early last year, but was stopped in the House of Representatives by organized interests of the parks.

We do not concede that any of our national parks will be ruined or even injured simply because the water that helps create scenery is put to useful work. We do not acquiesce with those who appear to think that the men who wish to harness America's "white coal" desire to wreck national parks. We do not believe that the esthetic and the utilitarian are necessarily opposed. We refuse to presume that conservation of water is the anathema of conservation of scenery.

We firmly believe that many water powers can be put to use without ruining our national parks and without detracting from their value as objects of nature. We feel confident that the interests behind the development of our water powers are not so one-sided as to wish or as short-sighted as to propose destroying the scenic beauty of our parks. Meanwhile it would be in the interests of everyone if the true facts were brought to light and both sides were to be heard from. Finally, the Water Power Commission, we feel confident, can be trusted with the people's interests.

Improving Business Conditions

Various opinions are current with regard to the business outlook for the current year. The majority of those connected with the electrical industry seem to have the impression that adverse conditions will be relieved early in the year, and that in any event the electrical fraternity will not be greatly affected by general conditions; that is, that the functions of the industry, taken as a whole, render it partially immune from any general depression. Some will say it is only the optimists that are responsible for such statements, but that there is a large element of truth is certain because financiers and other influential men outside of the industry have substantiated them.

Introspection reveals the fact that the electrical industry is rendering a large amount of service now considered indispensable. Central-station loads have not decreased, except in a few communities where manufacturers of non-essentials have ceased production, and in these cases the decreases are considered of a purely temporary character. Curtailed building operations and restricted buying have affected the sales of electrical supplies, but they are also of only present moment. Building must come and come quickly, and there certainly is no reduction in the potential field for the sale of appliances, not to speak of the demand for material due to extensions that must be made by central-station companies in order to supply adequate service to their respective communities. And there seems to be assurance that the necessary money to finance these extensions will be forthcoming during the year.

Taken all in all, the situation looks promising. And the encouraging part of it is that there is an undercurrent of feeling in the industry that improvement will come soon, with business on a satisfactory basis by midsummer. This undercurrent, by itself, will play no small part in effecting that very end, besides clearing up stagnant thoughts of some of those who are inclined to be pessimistic.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

TWENTY-SEVEN STATES LISTED IN POWER APPLICATIONS.

According to advices from Washington, D. C., there are included in 134 applications received up to Jan. 1 by the Federal Power Commission for permits or licenses under the water-power act passed by Congress last June, three from Minnesota, one from Illinois and one from Wisconsin. There are represented in the list of applications 27 states, 35 of the 134 coming from California, 13 from New York, 12 from Washington and ten from Montana. The application from Illinois is from the state itself for a license for navigation and power projects in the Desplaines and Illinois rivers in connection with the waterway now under construction.

A. I. E. E. TO HOLD CONVENTION IN NEW YORK CITY.

Program Includes Discussion of Oil Circuit-Breakers, Short-Circuit Current of Induction Motors and Generators and Other Subjects.

The midwinter convention of the American Institute of Electrical Engineers will be held Feb. 16-18 in the United Engineering Societies' building, 33 West 39th street, New York City. The convention will include six technical sessions, visits through various local power plants in the afternoon of Feb. 16, a dinner dance at the Hotel Astor Thursday evening, and the Edison medal presentation to Dr. M. I. Pupin on Friday evening, which will be followed by a lecture on recent advances in science. The tentative program for the technical sessions follows:

Wednesday Evening.—Address by President A. W. Berresford; "Symposium of Questionnaire on Oil Circuit-Breakers for the Protective Devices Committee," by H. R. Woodrow; "Tests on Oil Circuit-Breakers," by P. Torchio; moving pictures and oscillograph records of switches at the instant of failure.

Thursday Morning.—Sub-committee on Wires and Cables, Standards Committee. "Permissible Operating Temperatures of Impregnated Paper Insulation in Which the Dielectric Stress Is Low," by W. A. Del Mar, chairman; P. Torchio, D. W. Roper, W. S. Clark, R. W. Atkinson and L. L. Elden.

Thursday Afternoon.—Telephone and Telegraph Committee, D. McNichol, chairman. "Multiple Use of Wires," by S. Rhoads; "Carrier Wave Telephony," by F. B. Jewett and B. Gherardi.

Friday Morning.—Instruments and Measurements Committee, F. V. Magalhaes, chairman. "A New Design of Current Transformer," by H. B. Brooks and F. C. Holtz; "Regulation of Frequency for Purposes of Measurements," by P. H. Smith; "A New Type of Differential Voltmeter," by E. D. Doyle; "Variation of Eddy Currents in Conductors of Different Stranding," by J. A. Cooke; "Mechanical Wave Analyses," by F. S. Dellenbaugh; "Stopwatches," by A. L. Ellis.

Friday Afternoon.—Miscellaneous session. "Short-Circuit Current of Induction Motors and Generators," by R. E. Doherty and E. T. Williamson; "Hysteresis Phenomena With Superimposed Frequencies," by W. Fondiller; "The Longitudinal Flow of Heat in the Windings of Electrical Machinery," by C. J. Fechheimer.

MARYLAND PUBLIC SERVICE COMMISSION REORGANIZED.

Governor Ritchie of Maryland has approved a measure for reorganization of the staff of the state public service commission. Seven new appointees are to be added to the office, a number of present members promoted, with a total of $20,600 added to the annual salary list. Frank Harper, chief of the bureau of rates and tariffs, has been made executive secretary of the commission. B. W. Fendall, heretofore executive secretary, will become secretary to the commission at its meetings and will sit with it. Luke Ellis, assistant engineer, will become water engineer for the commission. The additional revenue required will be collected from the United Railways & Electric Co., Consolidated Gas, Electric Light & Power Co., and the Chesapeake & Potomac Telephone Co., all with headquarters at Baltimore, in the amounts of $8100, $6500 and $6000, in the order noted, and in accordance with an agreement made with the companies.

DECISION IN NEW JERSEY COMMISSIONERS CASE.

Utility Board Removed by Governor Continues to Function Pending Final Outcome of Appeal to Court of Errors and Appeals.

The Supreme Court of New Jersey handed down a decision Dec. 27 in the case brought by the Board of Public Utility Commissioners against removal from office by Governor Edwards, as occurred under recent date, upholding the action of the state executive. The decision over-ruled the demurrer filed by the board and sustains the constitutionality of the section of the state public utility act giving the governor power to remove from office upon charges. Since the time of removal from office several months ago the board has continued to function, and in view of the present situation will continue to do so.

An appeal has been taken by attorneys for the board to the Court of Errors and Appeals, and a final decision from this tribunal is not expected until early in June. Immediately following the Supreme Court decision, Governor Edwards called the senate in special session to confirm his

nominations for the new board, but this body refused to act in the matter and adjourned Dec. 30, taking a recess until Jan. 11, without according approval. The law-making body, when it again convenes will show a number of changes as a result of the last election.

In commenting upon the situation, John W. Slocum, president of the present board of utility commissioners, sets forth that the board will meet and conduct business as usual. He says: "We know of nothing to prevent us from functioning till the senate confirms the governor's appointees as our successors. Even then, the Court of Errors and Appeals may adjudge us within our rights in retaining office."

In addition to Mr. Slocum, the present board is composed of Andrew Gaul, George F. Wright and Harry L. Knight. For the new board, the governor has selected James A. Hamill, Jersey City; Treadwell Cleveland, Newark; James A. C. Johnson, Englewood, former state senator; Walter F. Whittemore, Newton, state highway commissioner, and Arthur A. Quinn, Perth Amboy, president of the State Federation of Labor.

NEW YORK CONTRACTOR-DEALERS TO HOLD ANNUAL MEETNG.

Albany has been selected as the city in which the annual meeting of the New York State Association of Electrical Contractor-Dealers will be held on Jan. 12-13. The sessions will take place in the auditorium of the Municipal Gas Co., 126 State street, and both the morning and afternoon of Jan. 12 will be devoted to executive committee meetings, when the question of redistricting the state will be considered.

On Thursday, Jan. 13, W. L. Goodwin, General Electric Co., and Samuel A. Chase, Westinghouse Electric & Manufacturing Co., will be among the speakers, and matters of interest to the contractor-dealer branch of the electrical industry will be discussed.

ADVOCATE EXTENSION OF PACIFIC CABLE SYSTEM.

Western Union Telegraph & Cable Co. Favors Laying of Two Cables from Seattle via Aleutian Islands to Far East.

Announcement made in December before the Senate committee by Newcomb Carlton, president of the Western Union Telegraph & Cable Co., that his idea of extensions of the Pacific cable system is for two cables from Seattle, Wash., one via the Aleutian Islands direct to Japan and the other to China, brings official approval to a route long advocated by the Pacific Northwest section and encouraged in the Orient. Significance is attached to this announcement in view of the fact that the Western Union company on Dec. 7 installed its direct New York-Seattle telegraph service, with the announcement that the equipment can be expanded to care for the increase which will come with a cable connection.

In its official statement as a result of investigations made with the co-operation of army engineers, presented to officials at Washington, the Seattle Chamber of Commerce points out the advantages of the route now favored by President Carlton. A cable touching on the Aleutian Islands would follow the great circle of navigation now used by ships coming from the Orient to Seattle, the shortest route across the Pacific. The present cable from San Francisco to Yokohama is 6993 nautical mi. long, while a cable laid from Seattle by the route suggested by President Carlton would be 4254 nautical mi. The gain in speed of transmission, considerable and important, is secondary only to the tremendous saving in initial construction costs and upkeep.

TO DISCUSS POWER DEVELOPMENT AT A. S. M. E. MEETINGS.

The Boston Section of the American Society of Mechanical Engineers will hold a joint meeting Jan. 18 with the Boston Section of the American Institute of Electrical Engineers. An address on the super-power system will be given by W. S. Murray, of the Super-Power Survey. The Feb. 8 meeting of the Boston Section, A. S. M. E., will be featured by a discussion on the water-power development and stand-by steam stations as applied to the general subject of power development in New England.

TWO ILLINOIS TELEPHONE SYSTEMS MERGED.

Chicago Telephone Co. Purchases Central Union Telephone Co.—Will Operate Systems Under Name of Illinois Bell Telephone Co.

Announcement has been made of the purchase by the Chicago Telephone Co. of the Illinois properties of the Central Union Telephone Co., and the merger of the two companies under the name of the Illinois Bell Telephone Co. The new company is officered by the same men who for years

SERVICE FIRST

A New Year Announcement

THE creation of one Company to handle the Bell telephone service of the entire State of Illinois, for many years the plan and hope of the Bell managers, is now accomplished, and the Illinois Bell Telephone Company henceforth will supply the service in place of the Chicago Telephone Company and the Central Union Telephone Company.

The successor is the Chicago Telephone Company with a new name; officered by the same men who for many years in the Chicago and Central Union Companies have devoted themselves to the development and operation of this great public service in the State.

B. E. Sunny, for twelve years President of the Chicago Company, continues in that office. Edgar S. Bloom, for seven years at the head of the Central Union Company, becomes a Vice-President, and W. R. Abbott, for many years General Manager of the Chicago Company, becomes Vice-President and General Manager.

The change in the name from "Chicago Telephone" and "Central Union" to "Illinois Bell" will be a source of regret to many Illinois men and women of two generations. While it is now a commonplace subject to the daily business and domestic routine, the telephone, in its uncanny effectiveness in extending the human voice, has not entirely lost the appeal to our wonder and amazement. Illinois people will pleasantly remember the names of the two companies that were so closely associated with forty years of development and service of Bell's remarkable invention.

* * * *

The successful prosperities of the Illinois Bell are best illustrated with a few figures:

It has 850,000 telephones. There are 340 other telephone companies in the State having 340,000 telephones. The Illinois Bell connects with these companies, making a total of 1,150,000 telephones in the State system.

It has 2,300,000 miles of wire.

It employs 20,000 men and women.

The book cost of the property employed is $387,000,000. (On the basis of present prices it would undoubtedly cost in excess of $200,000,000 to replace it.)

The new work to be done in 1921 calls for an expenditure of $14,500,000.

* * * *

The traffic department has won the long contest against the conditions destructive of good service which have prevailed for two years or more—an insufficient force of operators, unexperienced operators, etc. There is now a gratifying change and a marked improvement in the service.

Good progress has been made in reducing the number of unfilled orders for telephones—the result of the war condition—and except in cases where the shortage of facilities is extreme, it is hoped that applications can be cared for without delay.

Among the many tasks which confront the Illinois Bell is the further development of the toll service throughout the State. The important centers, Chicago on the east, Rockford on the north, Rock Island-Moline on the west, Cairo and East St. Louis on the south, Peoria in the middle of the State, require connection with each other by a perfect system, and in the same degree first-class telephone service must be provided and maintained between these and intermediate centers and with the smaller cities and villages around them.

The Illinois Bell will seek not only to extend and improve its own system of toll lines, but it will seek to strengthen telephone communication with the 340 connecting companies, as the interest of a faster and better service to all of the people in the State.

The Illinois Bell begins its career with the New Year and, in extending its greetings to its subscribers, expresses the hope that through the character of the service it will supply, it will always have their friendship and confidence.

ILLINOIS BELL TELEPHONE COMPANY

Announcement of Merger of Two Illinois Telephone Companies.

have operated the Bell telephone system in Illinois. B. E. Sunny, for 12 years president of the Chicago Telephone Co., continues in office. W. R. Abbott, for many years general manager of the Chicago company, was made a vice-president and remains as general manager, and Edgar S. Bloom, for seven years at the head of the Central Union Co., was elected a vice-president of the new company.

The new company has 810,000 telephones of its own and its lines connect with those of 340 other state companies having 340,000 telephones, making a total of 1,150,000 telephones which can be reached by this system in Illinois alone. It has 2,300,000 mi. of wire and employs 20,000 people. The new work to be done in 1921 calls for an expenditure of $14,500,000.

ELECTRICAL EXPORTS FOR OCTOBER SHOW INCREASE.

Total Amounts to $9,988,215, an Increase of $2,707,552 Compared With Same Month Last Year—Ten Months' Figure Is $77,658,171.

The exports of electrical goods to foreign countries for October were valued at $9,988,215, compared with $7,280,663 for the corresponding month in 1919, or an increase of $2,707,552. For ten months ending October, 1920, the total exports amounted to $77,658,171, an increase of $1,938,304 over the 1919 figures and an increase of $29,039,871 over the total for the ten months ending October, 1918.

The following classified figures give the detailed data for October, 1920, compared with the corresponding month last year:

Electrical machinery and appliances (except locomotives):	October, 1919.	October, 1920.
Batteries	$ 507,704	$ 483,109
Carbons	121,621	137,760
Dynamos and generators	452,946	970,840
Fans	79,406	55,212
Heating and cooking apparatus	164,114	182,715
Insulated wire and cables	487,444	575,041
Interior wiring supplies, including fixtures	168,902	282,999
Lamps—		
Arc	2,239	1,548
Incandescent—		
Carbon filament	6,075	16,871
Metal filament	334,835	354,536
Magnetos, spark plugs, etc.	222,972	317,891
Meters and measuring instruments	237,077	254,876
Motors	1,007,930	1,255,539
Rheostats and controllers	63,153	64,251
Switches and accessories	347,152	425,615
Telegraph apparatus, including wireless	44,566	24 751
Telephones	388,428	282,488
Transformers	218,789	785,300
All other	2,425,310	3,516,873
Total electrical machinery, etc.	$7,280,663	$9,988,215

S. E. D. STIMULATES INTEREST BY NEW PLAN.

A plan worthy of imitation was recently devised with most successful results by the Society for Electrical Development in connection with a feature article in the January issue of its *Monthly Sales Service*.

About a week before publication of the monthly a large printed post-card was sent to each member, conspicuously calling attention to an article entitled "What Retail Salesmanship Should Mean in 1921," appearing in the January issue. Indications of the interest created have been received in the form of requests for the bulletin from a number of recipients of post-cards whose copies were delayed on account of the congestion of the holiday mails.

This concise, pertinent article points out the falsity of the idea that selling means forcing another to buy something rather than showing the customer that electrical devices provide better conveniences, more comforts and greater service. It also enumerates four qualities essential to successful salesmanship: (1) know your goods and what they will do; (2) be prepared to demonstrate and describe their service convincingly; (3) show cost is low in comparison to service, or "sell the idea" and not the thing, and (4) maintain pleasant and attractive surroundings in the store.

ELECTRIFICATION PROGRESSES ON GOTHARD LINE.

A report from Switzerland indicates that the electrification of the Gothard railway line is progressing favorably and trial trips will soon be made on the section from Airolo to Biasca. Changes are now being made at Bellinzona, where the present railroad station is being remodelled and where a traffic station is nearing completion. As soon as these building operations are finished the section from Biasca to Bellinzona can also be operated by electricity. Shops for the repairing of electrical locomotives are being erected at Bellinzona.

COMING CONVENTIONS.

Iowa Engineering Society. Annual meeting, Des Moines, Ia., Jan. 18-20. Headquarters, Hotel Chamberlain.

Associated General Contractors of America. Second national conference, New Orleans, La., Jan. 25-27. Headquarters, Hotel Grunewald. Secretary, 111 West Washington street, Chicago.

Western Association of Electrical Inspectors. Annual convention, Detroit, Mich., Jan. 25-28. Headquarters, Hotel Statler. Secretary, William S. Boyd, 175 West Jackson boulevard, Chicago.

Pennsylvania State Association of Electrical Contractors and Dealers. Annual convention, Philadelphia, Jan. 26-27. Secretary, M. G. Sellers, 1518 Sansom street, Philadelphia.

Association of Municipal Electrical Utilities of Ontario. Semi-annual convention, Toronto, Can., Jan. 27-28.

National Council of Lighting Fixture Manufacturers. Annual convention and lighting fixture market, Elmwood Music Hall, Buffalo, N. Y., Feb. 14-19. Secretary, Charles H. Hofrichter, 8410 Lake avenue, Cleveland.

American Institute of Electrical Engineers. Midwinter convention, Engineering Societies building, New York City, Feb. 16-18. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

Joint meeting of Illinois State Electric Association. Illinois Electric Railways Association and Illinois Gas Association. Chicago, March 15-17. Headquarters, Sherman House. Secretary, R. V. Prather, Springfield, Ill.

American Electrochemical Society. Spring meeting. Atlantic City, N. J., April 21-23. Headquarters, Hotel Chalfonte. Secretary, Joseph W. Richards, Lehigh University, Bethlehem, Pa.

National Fire Protection Association. Annual convention, San Francisco, June 14-16. Secretary, Franklin H. Wentworth, 87 Milk street, Boston.

North Central Electric Association. Annual convention, Duluth, Minn., June 14-16. Secretary, H. E. Young, 15 South Fifth street, Minneapolis, Minn.

American Institute of Electrical Engineers. Annual convention jointly with the Pacific Coast convention, Salt Lake City, Utah, June 20-25. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

INDUSTRIAL EFFICENCY PROMOTED THROUGH WELFARE WORK.

Organization of Welfare Bureau of Edison Electric Illuminating Co. of Boston Outlined in Recent Address Before Company's Employes.

By H. W. Moses.

Superintendent of Employment Bureau.

The welfare bureau of the Edison Electric Illuminating Co. of Boston was organized Feb. 1, 1913, for three distinct purposes; first, assisting the employment office; second, the medical department, and, third, the accident prevention committee. It has been for these three departments that the work has been carried on.

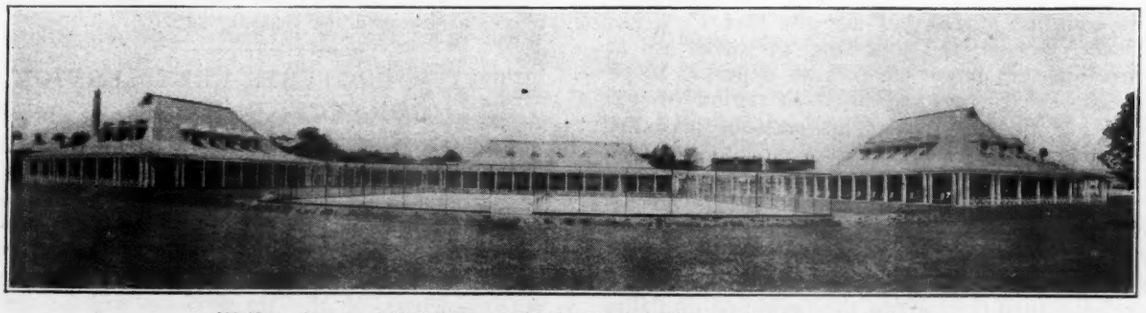
The question has often been asked as to what the company expects to accomplish by work of this kind. It must be appreciated that the carrying out of such work entails considerable expense, and the question is whether or not such expense is justifiable and whether or not the company has some motive in mind which the employe does not understand. The welfare bureau was formed to promote greater industrial efficiency through reduction in labor turnover. Such efficiency is not to be gained through the adoption of oppressive methods for the speeding up of production, but more through the development of a happy and contented group of employes who enjoy their work and who are best adapted to the work assigned to them and who will give long periods of service to the company.

Having obtained such a group of employes, who through their co-operative efforts are striving for a common end, it is felt that our industrial efficiency is affected to a marked degree by the regularity with which such employes attend to their work. In studying the causes of absences from work it is found that there are two principal factors which prevent regularity of attendance at work. One is disability due to sickness and the other is disability due to accident. The whole problem should be viewed from the standpoint that there are five hazards of life presented to all who are obliged to work for a living. When any one of these hazards is encountered it usually creates a hardship, and while the company is doing what it can through its disablement benefit plans it is nevertheless necessary and essential that the employe himself should appreciate these conditions and prepare himself as best he may to help meet them.

The hazards referred to are the hazards of unemployment, of sickness, of accident, of old-age dependency, and of death. The question is, what are you doing to protect yourselves against any of these conditions? For how long a period of time could you finance yourself and continue your present method of living in the event of any of the above misfortunes coming upon you?

In outlining the duties of the three principal features of the employment-bureau organization, first comes that of the employment office. The broad problem there is to study the causes of labor turnover within the company. In substance, labor turnover means the number of employes that have to be hired in any period of time in order to keep a sufficient working force to carry on the company's business. It is not at all unusual for labor turnover to vary from 100 to 600%, which means, in other words, that an industry employing nominally 1000 employes must in the course of a year hire from 1000 to 6000 employes to maintain the necessary working force of 1000. Such a condition obviously is expensive and reduces efficiency because of the fact that employes do not stay long enough to carry on their respective duties in the most efficient manner, and, therefore, it is one of the principal functions of the employment office to study carefully the causes of these separations. The employment office also keeps in touch with various sources of labor supply so as to be able to fill vacancies promptly. Having a knowledge of the vacancies occurring from titme to time an attempt is made to promote and transfer employes from one department to another so that the relatively higher positions may be filled from within the organization.

One of the principal duties of the medical department is the physical examination of new



Welfare Group of Buildings of Edison Electric Illuminating Co. of Boston.

employes. The entire organization is along the line of health promotion, its broad questions being to study "What Does Sickness Cost the Company?" "What Are the Causes?" "and What Are the Remedies and the Days Lost?" We are attempting to get at the problem through carefully tabulated reports of all cases by departments.

The duties of the accident prevention committee are primarily to study the causes and remedies for accidents arising out of the course of our business. The work is carried on by a committee of five appointed annually by the president, which committee meets weekly to discuss the cases which have happened, to make recommendations to prevent the recurrence of accidents, and to choose and distribute safety bulletins and other pamphlets which will have the tendency to reduce the number of company accidents.

Benefit Plans to Provide for Disability Due to Sickness.

Under the heading of tangible results are included the accident, sickness and death benefits and service annuities. In seven years the company has paid out to employes approximately $164,000 under its welfare bureau plan. Under the heading of intangible results would be included the employes' building at Massachusetts avenue, the annual field day, the loan fund previously carried on but which has since been replaced by a successful savings fund, the war gardens, legal aid and the services of the medical department, through which during the past seven years more than 16,000 house visits have been made to employes while confined to their homes.

The fundamental features governing the benefit plans are based upon the employe's length of service with the company. In cases of disability due to sickness the employe is transferred to the disability payroll on the fifteenth day of consecutive illness, the first two weeks' period being taken care of by his department under rules governing the first 14 days of disability. Disability pay continues for one-quarter of the number of weeks that the employe has been with the company, with a maximum of 500 weeks. Thus, if an employe has been in the service one year he will draw disability pay for three months; if he has been with the company five years the disability pay would be continued for one and one-quarter years, and if he has been in the service ten years the disability pay would be continued for two and one-half years, and so on, provided, of course, the disability lasted for any such period of time. Having determined the total maximum time for which benefits will be paid the disablement benefits continue at full pay for the first 13 weeks of such period, the following 13 weeks are at three-quarters pay, then follows a period of 78 weeks at half pay and finally a period of 396 weeks at quarter pay. This class of disability includes not only sickness but accidents sustained while off duty.

The payment of disablement benefits on account of injury arising out of one's employment is handled somewhat similarly to the cases of sickness, with the exception that the payments are continued throughout the period of disability irrespective of the length of time that the employe has been with the company. On account of the protective features of the workmen's compensation act, the company does not pay the entire expense of disablement benefits in cases of injury. Beginning the eleventh day of continuous absence due to injury, the company contributes the difference between the amount allowed under the workmen's compensation act and the employe's full pay, such allowance being made for 13 weeks. For the 13 weeks next following, the company contributes an amount in excess of the allowance of the compensation act to make up three-quarters pay and likewise contributes up to one-half and one-quarter pay for the periods above specified. In no case, however, does the injured employe ever receive an amount less than the sum provided for under the workmen's compensation act.

The death benefit provides for the payment to dependents of employes who die of natural causes while in the company's employ the sum of $100, plus $50 for each full year of continuous service completed, with a maximum of $600. In the case of an employe dying from natural causes and leaving no dependents the company pays funeral expenses not exceeding $200. In the case of fatal accidents the terms of the workmen's compensation act being so much more liberal than the company's plan of death benefits no payment is made to the dependents, with the exception that where dependents are left the company pays funeral expenses of such fatally injured employes, such amount, however, not in excess of $200.

Three provisions are made in the service annuity plan covering eligibility for retirement. First, a male employe arriving at the age of 65, and having been in continuous active service of the company or any of its predecessors for a period of 15 years, may be retired with a service annuity at his own request, or at the discretion of the service annuity committee. In the case of female employes the required age is five years less than for male employes. The two other provisions of the service annuity plan provide for the retirement of employes at ages less than 65, the length of servce being 20 and 30 years respectively. Retirement in such cases, however, is only at the discretion of the service annuity committee and was inserted in the plan for the purpose of providing for the retirement of employes of long standing who may have become permanently incapacitated or unfit for their work before arriving at the age of 65. In the perfection of the service annuity plans the management was particularly careful to provide for the permanency of the plan so as to give adequate protection throughout the years to come to employes arriving at the pension age.

UTILITY PROTESTS FREE SERVICE CONNECTION ORDER.

Effective Dec. 15, the Public Service Electric Co., Newark, N. J., has been making free service connections in its entire territory, in accordance with a recent order of the Board of Public Utility Commissioners of New Jersey. The company has protested the order and it is said that the reasonableness of the instructions will be decided in the courts.

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

OPERATION OF LEAD-OXIDE LIGHTNING ARRESTERS.

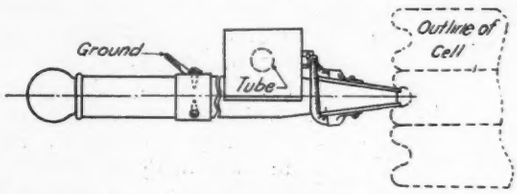
Individual Cells Should Be Tested at Start and Finish of Each Lightning Season, and All Defective Parts Should Be Replaced.

After the initial charge has been given to a lead-oxide lightning arrester the only attention required in its operation is systematic inspection once a month, and after each lightning storm, to see that it is in good condition and affording effective protection. This inspection should include fuses, gaps, nuts which clamp the cells, cells and connections. If the fuses are blown the cell stacks should be inspected, and if the cells show no signs of damage they should be refused with 0.085-in. tin fuse wire or any standard 15-ampere fuse wire. When the fuses are out check the gaps to see that they are set correctly and are clear, and wipe the hemispheres and insulators off occasionally with a clean cloth. The nuts which clamp the cells should be tightened to take care of any settling of the compound in the cells. The line and ground connections should be checked to make sure they are tight and in good condition.

It is not necessary to test the cells until the end of the first season, but after the first season all cells should be tested at the beginning and end of every lightning season. This can be easily and quickly done with the testing device shown in the accompanying illustration and supplied with each shipment of arresters.

The testing device is used to indicate the condition of each cell of the arrester. It consists of a glass vacuum tube inclosed in a small wooden box fastened in a slot near the beveled end of a specially constructed switch stick. Two brass contacts, insulated from each other, are fastened to the side of the beveled portion of the stick and connect to the terminals in the box which protects the vacuum tube. By inserting the beveled end of the stick between two metal cell plates, as shown in the illustration, the vacuum tube is placed in shunt with the cell. With voltage on the arrester, if the cell under test is not in normal condition, the vacuum tube will glow. By "glow" is meant a heavy power glow and not a blue static glow such as is obtained by bringing the tube near the line terminal or if the metal contacts on the testing stick do not make good contact with the metal cell plates.

To test an arrester the fuses should first be pulled, and each cell stack should be discharged to ground. On outdoor arresters the front shields must be removed. Then the arrester should be reconnected to the line by replacing the fuse holders in the cutouts. With a fuse hook draw an arc across each of the horn gaps in turn. The arc should not be a heavy power arc, but should there be some indications that such is the case, and if the arc does not decrease after seven or eight times, or, if the cells show much internal stress, discontinue the operation and check condition of the circuit and arrester connections. If the circuit and arrester conditions



Testing Device for Lead-Oxide Lightning-Arrester Cells.

are normal and the cells continue to show internal stress they should be replaced with new cells and steps taken to find the source of trouble.

If the arc appears normal one of the gaps should be short-circuited and the individual cells in the ground leg examined with the testing device. Then another gap, making two gaps, should be short-circuited, and each cell in the two line legs with short-circuited gaps should be tested. Following this the short-circuit should be removed from one gap and applied to the third one. Then the cells in this last leg should be tried out. In case that unusual circumstances are developed by the test, the conditions should be taken up with some authorized person competent to dispose of the matter, or directly with the manufacturer. It should be remembered that the cells are tested to locate faults, and if a fault is found but not properly corrected it might as well not have been found. In case there is any question as to how to proceed in short-circuiting the gaps, or in any other procedure, detailed instructions should be secured from the manufacturer.

ANALYZING OF COAL BY THE BUREAU OF MINES.

One of the functions of the United States Bureau of Mines is the analyzing of the coals used by the government. In explaining the nature of this work Dr. F. G. Cottrell, director of the bureau, made the following statement:

"A large service laboratory is maintained which analyses all government coal purchases, and, in addition, thousands of samples each year which are collected by bureau field engineers. Thus, gradually, there is being accumulated exact information as to the nature and character of every kind of coal from every district in the country. In the actual testing work special attention has been given to the economic combustion of coal by the small user, represented mainly by the small hand-fired boiler plant and by the domestic consumer. It has been easier and cheaper,

also, to study the small furnace, and much fundamental data has been obtained and disseminated as to what actually takes place in the furnace during combustion of the fuel. Utilization of lower grade and cheaper fuels as substitutes for more costly fuels has been demonstrated and put into effect in many lines. Startling wastes of energy in the ordinary plants have been proved and brought to the attention of the public. Today, the situation is more alive and more worthy of attention than ever before. In prewar days, with coal in many regions available at about a dollar a ton, care, refinements, and possible saving of energy were often a matter of technical interest only, while today, with coal at several times the above price, even small savings of fuel are a dividend-paying necessity.

"To the fuel engineer the possibilities for the future are almost without limit. To the man who doubts the wisdom of research with public money here is a field where the initial expenses of establishing and conducting real research are too great to justify private individuals or corporations to undertake, from the standpoint of money returns to themselves alone; yet, because the results of the research affect thousands of furnaces, each in a small way, the aggregate nation-wide benefit is immeasurably more than the initial expenditure. The successful researches of the bureau of mines with natural-gas heating and cooking appliances are a case in view.

"For the future, the public must realize that the serious city smoke troubles are remedial nuisances, dependent for remedy equally on the public, the fuel engineer, the consumer of coal, and the fireman. Either the fireman and the man for whom he works must be taught to burn the coal without smoke, or else artificially prepared fuels from which the smoke forming tars and volatiles have been taken must be used. In both lines the interest of the bureau is paramount. The program should be: First, investigating, teaching, and educating the great fuel-burning public to the money and health value of the right fuel, and the right furnace in the right place, fired in the right way; second, aiding in the development of preparing new fuels, especially from waste and low-grade fuels."

FIRE-EXTINGUISHER BOMBS MADE FROM OLD LAMP BULBS.

Carbon Tetrachloride Sealed in Glass Containers Makes Effective Equipment for Power-Plant Service.

The dangers of fire and the resulting electrical hazards must be guarded against in and around every power plant. The use of water as a fire extinguisher is objectionable in many cases and is exceedingly dangerous in many others. Carbon-tetrachloride bombs have found favor in many plants, and their use has resulted in the prompt quenching of fires that might have resulted in serious consequences if quick action had not been taken. The accompanying illustration taken from the *Bulletin* of the National Safety Council shows a basket of bombs made from old incandescent lamp bulbs.

Burned-out bulbs of a suitable size are made into bombs by removing the metal base and filling the glass bulb with the liquid. The filling operation may be accomplished by breaking the tip from the bulb while immersed in a bucket of carbon tetrachloride. A drop of wax is placed over the small hole at the tip of the glass after it has been filled. Bombs of this character may be

Basket of Home-Made Carbon-Tetrachloride Bombs.

mounted in suitable places around the plant, or may be kept in a basket like that shown for convenient use.

GOOD EFFICIENCY OBTAINED WITH LOW-GRADE FUEL.

Record of Test on a 500-Hp. Stirling Boiler Burning Utah Slack With an Automatic Stoker Equipment.

The accompanying data was compiled as the result of a boiler test conducted in the plant of the Utah Oil Refining Co., Salt Lake City, Utah. The test was made to determine the efficiency of the equipment for an 8-hr. period at approximately 150% rating. The boiler used was of Stirling make and was rated at 500 hp. The fuel was burned on a five-retort Jones stoker. Water was measured by meter and the fuel was weighed on a wheelbarrow platform.

An efficiency of 76.23% as obtained in this test is quite good considering the character of fuel used.

DATA FROM TEST OF 500-HP. STOKER-FIRED BOILER.

Conditions.	Quantities.
Duration of test, hours	8.000
Steam pressure, lbs. gauge	139.900
Feed-water temperature, deg. F.	186.700
Flue-gas temperature, deg. F.	584.800
Carbon dioxide (CO_2), %	12.200
Coal as fired. lbs.	20,760.000
Dry refuse, lbs.	1,595 000
Water fed to boiler. lbs.	184,713.000
Factor of evaporation	1.071
Equivalent evaporation, lbs.	197,827.600
Combustible in dry refuse, %	11 500
Analysis of fuel:	
Fixed carbon, %	47.170
Volatile matter, %	37.840
Ash, %	12.450
Moisture, %	2.540
B.t.u. per lb., dry	12,449.000
B.t.u. per lb. as fired	12,121.000
Summary:	
Coal burned per hour as fired, lbs.	2.595.000
Water evaporated (equivalent) per hour, lbs.	24,728.400
Water evaporated (equivalent) per hour per sq. ft. of heating surface, lbs.	4.940
Average boiler horsepower developed	716.800
Water evaporated per lb. of coal as fired, lbs.	9.530
Water evaporated (equivalent) per lb. of dry coal, lbs.	9.780
Water evaporated (equivalent) per lb. of combustible, lbs.	11.470
Heat lost in stack gases, %	14.860
Heat lost in unburned combustible in refuse, %	1.060
Efficiency of boiler, furnace and grate, %	76.230

NEW APPLIANCES

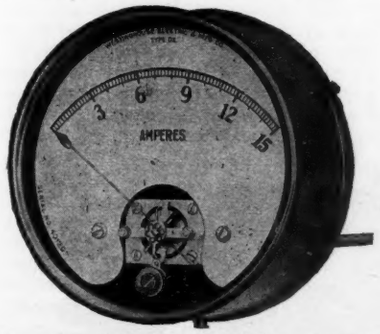
Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Ammeters and Voltmeters for Special Applications.

The type DX instruments placed upon the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., are especially suitable for use on switchboard panels, radio-communication sets and on farm-lighting and other small charging and lighting panels. They are also suitable for use on marine, dental, telephone, and telegraph panels. The instruments may be used in conjunction with a magneto to indicate speed as well as in conjunction with search coils to indicate temperature. These instruments operate on the D'Arsonval principle, and are capable of standing vibration such as is found on shipboard without impairing their accuracy and reliability; hence, the combination of ruggedness and lightness of moving parts is provided. A sensitive galvanometer can be made, using this movement. The case of the instrument is punched from sheet metal and is made moisture proof. An external zero adjuster on the front of the case allows a resetting of the zero position of the pointer in case it is displaced in transportation or by shock. All parts are mounted on a moulded subbase which assures sufficient insulation.

Ammeters are furnished self-contained up to and including high capacities for use with shunts. The voltmeters are furnished self-contained up to a capacity of 500 volts. They can be furnished for higher voltages with external resistances.

Radio-frequency instruments operate on the heat principle. The current to be measured passes through a resistance strip which is heated in proportion to the square of the current passing through it. The temperature of this strip is therefore proportional to the current. Measurement of the temperature was accomplished originally by measuring the expansion of the strip by mechanical means, but this method

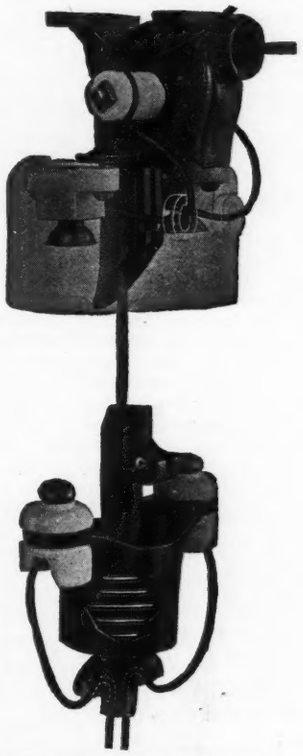


Ammeter Suitable for Various Special Applications.

is not very accurate. By fastening a thermocouple on the heating strip the temperature can be measured very accurately with a D'Arsonval Instrument. On the type DX instrument the heating strip and thermocouple are mounted as a unit. These units are interchangeable on instruments of the same capacity. Special ammeters for measuring high-frequency currents of low capacity can be made up by using heaters and thermocouples mounted in gas-filled bulbs.

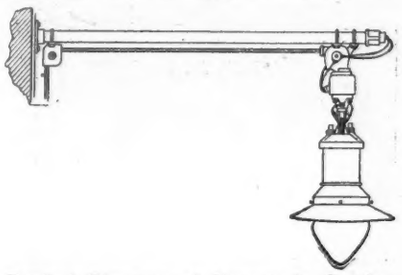
Safety Disconnecting Hanger for Industrial Units.

Industrial lighting fixtures are suspended in a great variety of places and are often difficult to reach for cleaning, inspection or renewal of bulbs. Particularly in dusty locations the lamp bulb and reflector should be cleaned at frequent intervals to maintain the proper illuminating efficiency. With fixed units high above the floor cleaning is both expensive and hazardous. The Thompson safety disconnecting hanger, being made by the Thompson Electric Co., Cleveland, O., has been designed to obviate the costs and hazards of cleaning high fixtures or fixtures located in places difficult to approach in safety.



Phantom View of Hanger Showing Guides and Connections.

As may be seen from the illustrations, the movable locking catch or dog is attached to the separable portion of the hanger and is lowered with the fixture. This type of construction makes it possible to inspect and clean the locking device if required at each cleaning of the reflector. The only movable part of the hanger not lowered with the lamp is the pulley, and it is of such construction as not to need attention. A



Typical Diagram of Hanger in Service.

shaped lip on the upper member assures the proper coupling of the hanger under all circumstances and guides the contacts to their proper seat. A pull on the line is all that is required to lock the lamp in place, and a second pull releases it ready for lowering and cleaning.

Industrial units of all types may be suspended from these hangers with satisfactory results. It is said that their use eliminates danger from shock, danger of falling from a ladder or other support, and greatly reduces the costs of maintenance. The use of such devices with lamps suspended in difficult positions permits of better maintenance practices and so provides more and better lighting from a given expenditure of money for power.

Steam Turbines Suitable for Mechanical Drive.

A new steam turbine suitable for connection to centrifugal pumps, blowers, etc., is being placed on the market by the General Electric Co., Schenectady, N. Y. This turbine is of the standard General Electric Curtis type, but many of the details are worked out along modified lines based on experience, and the new turbine is being offered in the belief that it will fully meet the requirements of the man in the power house.

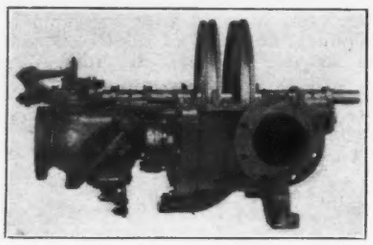
Practical operation has been given first consideration, and this turbine should require a minimum of attention. All parts subject to stress are designed with a liberal margin of safety.

The machine may be arranged to operate at steam pressures from 50 to 300 lbs., with or without superheat, and either noncondensing or condensing. It is, in general, adapted to supplying an output anywhere from 10 to 400 hp. at speeds of from 1000 to 5000 r. p. m. It may have one, two or three stages; a stage consists of a compartment or chamber in which the wheel revolves, the nozzle, and intermediate buckets. In a two-stage turbine the second stage is separated from the first by a diaphragm in the casing, the nozzle for the second stage consisting of suitable

openings for the passage of steam through this diaphragm.

The accompanying illustration shows a two-stage turbine with speed governor mounted on one end of the shaft and the other end arranged to receive a coupling. With the upper half of the wheel casing and bearings removed, as shown, the removal of the wheels and shaft may be accomplished without disturbing the steam and exhaust piping.

The wheel casing is made of cast



Two-Stage Turbine With Upper Section of Shell Removed.

iron of ample body for safety and rigidity. It is divided horizontally into upper and lower halves, and the upper half may be readily lifted for inspection or removal of wheels. This may be done without breaking joints in the steam or exhaust pipes as these are connected to the lower half of the wheel casing. The upper and lower halves of the casing are machined and fitted together with a metal to metal joint. The casing is supported at three points which does away with the possibility of twisting strains. Bearing brackets are bolted to the casing, and are fitted to insure good alignment. The bearings are made of top and bottom cast-iron shells and are babbit lined. They are lubricated by means of oil rings dipping into ample oil reservoirs.

The wheel consists of a steel disk turned to shape and keyed to the shaft. Two dovetail grooves are turned in the rim, the buckets being dovetailed into these grooves. Between the two rows of revolving buckets in each stage are the stationary intermediate buckets for reversing the steam flow. The shaft is made of steel with one end arranged for a coupling fit, the other end carrying the governor which is of the centrifugal tension-spring type. The governor weights pivot on hardened knife edges of ample width to reduce wear to a minimum. The motion of the governor weights is transmitted through ball-bearing connections to the governor valve. This valve is of the balanced-piston type, and is practically frictionless.

Governor weights are completely inclosed in a casing and a protecting hood is placed over the governor as a whole. A wire-mesh strainer is placed in the steam chest in front of the governor valve to prevent solid particles from entering the turbine.

When conditions of operation render it desirable an emergency governor is supplied. This governor operates entirely independent of the main governor and serves as an added protection. It does not come into play unless the speed rises to about 15% above normal, when it shuts off the steam supply. This governor is of the simplest possible construction, consisting of two flat springs secured at one end to a disk. When the position of the springs, or of either one of them, is altered by centrifugal force it strikes a trigger which releases a simple flap valve in the steam chest and stops the flow of steam.

From the steam chest steam is passed through the first-stage nozzles which direct the flow of steam into the buckets on the wheel. For some purposes some of the nozzles are opened or closed as required by hand valves placed in the steam chest. Steam to all nozzles is under control of the main and emergency governors.

Soft fibrous metallic packing is, in general, used where the shaft passes through the casing, but for condensing and high-back-pressure operation carbon packing is used. A steam seal is provided for condensing operation.

Phase-Sequence Indicator.

To enable phase sequence to be determined easily the States Co., Hartford, Conn., is placing on the market a compact portable indicating device. It is so designed that a pilot lamp set in a recess in the case indicates by its brightness or dimness the direction of phase rotation. A push button in the case reverses two of the leads and provides the contrasting indications of the lamp by modifying the magnetic flux of the interior coil windings. The device has no moving parts and weighs less than 3 lbs.

Test Set for Automobile Circuits.

The test set manufactured by the F. B. Electric & Manufacturing Co., Detroit, consists of three ammeters and three voltmeters specially designed for use in making necessary tests to determine starting and lighting troubles. The instruments are contained in one case with two sets of cables. Zero center correction may be applied, and a special scale is shown in different colors and special markings for making cadmium tests.

Watchman's Clock System.

The E. Howard Clock Co., Boston, has developed a watchman's clock system requiring two wires per circuit, with an indefinite number of boxes on a circuit connected in multiple. Each clock makes its own distinctive number record. The station number and time of recording are shown as a perforated record on a paper dial.

Pulverized-Coal Equipment for Steam Boilers.

Pulverized or powdered coal has for many years been recognized as a desirable form of fuel. It has not until recently been used under boilers on account of the difficulty of pulverizing the coal to sufficient fineness. Many of the difficulties are now said to have been overcome by the Aero pulverizer made by the Erie City Iron Works, Erie, Pa.

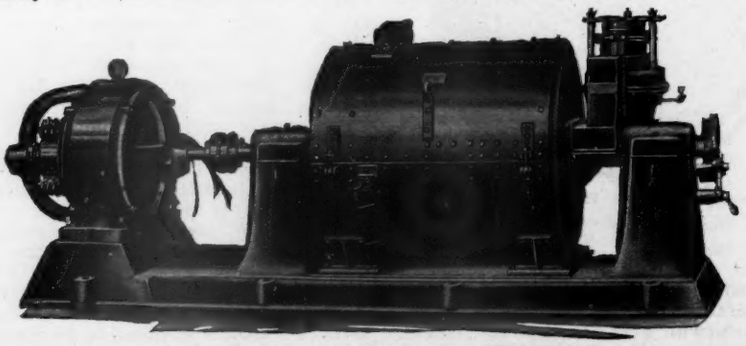
The usual method of providing and using pulverized coal is to crush the coal, dry it, pulverize it, store it in the pulverized state, distribute it to the different boilers, convey it toward the boiler and blow it in, the blowing-in apparatus being called the burner. This requires an elaborate equipment and has not as yet been applied advantageously to plants of less than 2500-hp. capacity. In consequence of this the advantages of pulverized coal could not be utilized in any but large steam plants, and, in general, only in central power stations.

The new system of pulverized-coal preparation and use is free from the ponderousness and complication above described. No drying or storage of the pulverized coal is required, it being pulverized as wanted, immediately blown into the furnace with the necessary air for combustion with as high CO_2 content in the gases as has been realized by other means. The pulverizer and burner are a unit. The whole apparatus is small and can be placed in any position near to or far from the boiler.

Pulverized coal should be of such fineness that a large percentage of it will pass through a screen of 200 mesh to the inch. When such fuel combined with air enters an incandescent furnace it instantly bursts into flame, and, as the air can be adjusted to provide the proper amount of oxygen to suit the requirements, the combustion can be more easily regulated than with other means of burning coal.

The new pulverizer consists of a cylindrical case resting upon a bed plate and having a longitudinal shaft in the center on which there are paddles for most of its length and a fan at the delivery end. This shaft runs at a speed of approximately 1000 r.p.m. Coal is received at the opposite end from the fan in pieces of regular crusher sizes. The paddles receive it and subject it to such treatment that it is pulverized when it reaches the fan. When this occurs the fan lifts it and blows it into the furnace. Thus this simple and portable apparatus, becomes the pulverizer and burner, no drying being required, and it is said that the fuel will travel any ordinary distance through a metal pipe to the furnace.

The quantity of coal is regulated by a gate at the receiving end, and the air is admitted at several points as developed by experiment.



Coal Pulverizer and Blower in a Single Unit.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Oneida Electric Co., 313 Canal street, New York City, sustained a loss by fire Dec. 24.

Vatter Co., Louisville, Ky., manufacturer of batteries, has increased its capital stock from $20,000 to $40,000.

Apex Electric Manufacturing Co., 1410 West 59th street, Chicago, has increased its capital stock to $100,000.

Gregory Electric Co., 1601 South Lincoln street, Chicago, has increased its capital stock from $300,000 to $1,000,000.

Capital Theatrical Electrical Supply Co. has leased property at 352 West 50th street, New York City, for a new local establishment.

Simms Magneto Co., North Arlington avenue, East Orange, N. J., plans to increase its capital stock from $1,500,000 to $2,000,000.

Westinghouse Union Battery Co., Swissvale, Pa., plans to erect a plant on a site adjacent to the building of the Union Switch & Signal Co.

Franklin Appliance Corp., Elizabeth, N. J., manufacturer of electrical specialties, conduits, etc., has changed its name to the Franklin Conduits Co.

Sunshine Safety Lamp Co., 1005 McGee street, Kansas City, Mo., plans to erect a one-story and basement plant, 50 by 115 ft., on Walnut street.

Armstrong Cork Co., manufacturer of insulation products, Pittsburgh, has arranged for a bond issue of $6,000,000 for general operation and expansion.

Chicago Ignition Supply Co., 308 North Michigan avenue, Chicago, manufacturer of ignition equipment, has changed its name to the Boulevard Ignition Co.

A. C. Gilbert Co., Blatchley avenue, New Haven, Conn., manufacturer of electric fans, etc., plans to erect a one-story addition, 26 by 240 ft., to its present plant.

New Jersey Lamp Works, 21 William street, Newark, N. J., has recently perfected plans for a new department to manufacture a patented core for automobile radiators.

National X-Ray Reflector Co., Chicago, has distributed to the electrical trade a 1921 calendar, each sheet of which contains some specific suggestion for a lighting installation.

United States Light & Heat Corp., Niagara Falls, N. Y., manufacturer of electric storage batteries and kindred equipment, has arranged for a stock issue of $1,500,000, the proceeds to be used for general business operations and expansion.

Mutual Electric & Machine Co., manufacturer, engineer and designer of switches, switchboards, cutouts, panelboards, cabinets, etc., which recently increased its capital stock from $100,000 to $500,000, has been located in Detroit for the last six years. The company does not now maintain an office in Wheeling, W. Va., as erroneously stated in our issue of Dec. 11.

Briggs & Stratton Co., 1047 Louis avenue, Milwaukee, manufacturer of ignition specialties for the automotive industry, has increased its capital stock from $1,700,000 to $1,950,000.

Whitman Electric Manufacturing Co., Whitman, Mass., has made arrangements with J. J. Wirtner, Wells Fargo building, San Francisco, to represent it on the Pacific Coast.

Collon Electric Washer Co., New York City, has filed notice of reorganization with active operating capital of $440,000, to manufacture electrically operated washing machinery.

Schaeffer & Budenberg Manufacturing Co., 338 Berry street, Brooklyn, N. Y., manufacturer of steam gauges and other power plant specialties, has increased its capital stock from $100,000 to $1,000,000.

Utica Electric Sun Signs, Inc., Utica, N. Y., has filed notice of reorganization with an active capital of $40,000, preferred stock to the value of $35,000, and 1000 shares of common stock of no par value.

Davis Sewing Machine Co., Dayton, O., which recently purchased the assets and good-will of the Blue Bird Manufacturing Co., will continue the manufacture and sale of the "Blue Bird" electric clothes washer.

Syracuse Washing Machine Corp., Syracuse, N. Y., manufacturer of electrically operated washing machinery, has filed notice of increase in its capital stock from $6,500,000 to $7,000,000 for proposed expansion.

C. F. Pease Co., 813 North Franklin street, Chicago, has issued its catalog S-21 on engineers' and surveyors' field and office supplies, which lists drawing, profile and cross-section papers, tracing cloths, blueprint papers and blueprinting machines, drafting room furniture and such field supplies as transits, levels, ranging poles, leveling rods, etc.

Cutler-Hammer Manufacturing Co., Milwaukee, has announced that in order to take care of the increasing amount of business done in the St. Louis territory it has established a branch office in suite 2111, Railway Exchange building, St. Louis, in charge of Harold Phillips, formerly of the engineering department of Chicago and later office manager of the Chicago office. The St. Louis office is a branch of the Chicago district office.

Tele-Call Co., 5604 Cedar avenue, Southeast, Cleveland, has issued a booklet setting forth the advantages of installing its "Tele-Call" equipment in a business institution. The system is used in connection with the telephone and enables the operator to locate instantly any member of an organization without the necessity of having the office boy page the party wanted, thus saving time. Other features of the device are also touched upon in the pamphlet.

Luminous Unit Co. Division of the St. Louis Brass Manufacturing Co., St. Louis, has issued catalog No. 8 covering its line of "Brascolite," "Industrolite," "Aglite" and "E-Lite" lighting fixtures, also "Lumo Vitro" porcelain enameled switch plates.

Triangle Conduit Co., Inc., 52 Columbia Heights, Brooklyn, N. Y., has appointed T. H. Bibber to take charge of its specialty lines. Among the articles manufactured are "Tri-cord," a flexible conductor cord with knit cover used for heavy duty portable extensions. The officers of the company are: President, James R. Strong; vice-president, V. C. Gilpin, and treasurer, J. E. McAuliffe.

The Chase-Shawmut Co., Newburyport, Mass., manufacturer of electrical material, has called attention to a slight discrepancy in the announcement regarding the company which appeared in the Dec. 18 issue. The old concern was operated under the name of Chase-Shawmut Co., while the new firm bears the title of The Chase-Shawmut Co., the principal product which it manufactures being inclosed fuses.

Magic Electric Coffee Machine Co., 1218 Fifth avenue, Seattle, Wash., of which E. L. McGrory is president and treasurer, has announced that it will shortly place on the market an electric coffee-roasting, grinding and weighing machine, plans for which have been completed by Robert L. Rockwell, consulting engineer, Empire building, Seattle. Bids are being received for the manufacture of the machines under patents granted the inventor, F. A. Wilcox, secretary of the company. Herbert S. Wilson, chemist and coffee-analysis expert, Fisher building, Chicago, has reported the product from these machines to be superior to that obtained by the ordinary process of roasting.

Standard Underground Cable Co., Pittsburgh, has announced the following changes in its Pacific Coast staff: Richard G. Harris succeeds John P. Bell as Pacific Coast manager, who will hereafter devote his time to the growing demands of his export and import business. Mr. Harris has been connected with the Standard organization since 1909, when he was a member of the general office staff at Pittsburgh and assigned to special development matters at its Perth Amboy, N. J., factories, being later employed as sales engineer at the New York office of the company. For the past eight years he has been manager of the Montreal office territory of the Standard Underground Cable Co. of Canada, Ltd. Vinton Smith, who has been connected with the San Francisco office staff for several years, has been appointed assistant manager of the Pacific Coast territory, and W. G. Stearns, who has also been connected with the company on the Pacific Coast for many years, has been appointed special sales agent.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

J. DUGAL WHITE has been elected a director of the J. G. White Engineering Corp., New York City.

L. H. KINNARD, president of the Bell Telephone Co. of Pennsylvania, Philadelphia, has been elected a director of the Bank of North America, Philadelphia.

J. L. FINNICUM has resigned his position as sales manager of the Thordarson Electric Manufacturing Co., 509 South Jefferson street, Chicago. He has not yet announced his plans for the future.

W. A. GREENLEAF, former Pittsburgh district manager for the Allis-Chalmers Manufacturing Co., Milwaukee, has become connected with the Erie-Ball Engine Co., Pittsburgh, in charge of sales.

F. N. AVERILL, manager of the Fobes Supply Co., Portland, Ore., wholesaler of electrical supplies, has been elected chairman of the finance committee of the Northwest Electric Service League.

SAMUEL W. DUDLEY, chief engineer of the Westinghouse Airbrake Co., has been appointed professor of mechanical engineering on the Strathcona Foundation by the Yale Corp., New Haven, Conn.

T. W. FLOWERS, formerly secretary and treasurer of the Cohoes (N. Y.) Power & Light Corp., is now connected with the J. G. White Management Corp., New York City, as assistant auditor of the Manila (P. I.) Electric Co.

T. H. CEPERLEY has resigned as chief operating engineer of the power and substations of the Albany Southern Railroad Co. on account of ill health. He was formerly connected with the Newburgh (N. Y.) Light, Heat & Power Co. as chief engineer.

H. F. HILL has resigned as operating vice-president of the Chicago Telephone Co. and the Wisconsin Telephone Co. and opened offices in the Nottingham building, 25 Huntington avenue, Boston, as a consulting expert for public utility and industrial corporations.

A. G. WISHON, formerly general manager of the San Joaquin Light & Power Corp., Fresno, Cal., has been elected vice-president and managing director of the company. A. Emory Wishon, who has been assistant general manager for several years, has been promoted to the position of general manager.

D. GUIDO VERNACI, foreign sales promoter and manager of Italian and South American sales of Viele, Blackwell & Buck, hydroelectric engineers, exporters and importers, who recently returned from an extensive business trip to Brazil and Argentina, has resigned to accept a position with the International General Electric Co. Mr. Vernaci will engage in electrical merchandising with ultimate destination to one of the South American fields.

E. L. BRADBURY, assistant sales manager of the Holophane Glass Works of General Electric Co., recently returned from an extensive trip in the Southwest where he has been stimulating interest in better illumination. Mr. Bradbury reports an encouraging outlook for the new year in the states of Oklahoma and Texas. He finds the trade in that section is alive to the fact that there are large sales possibilities for the man who will push good illumination.

H. R. KING, who has been power and light sales manager of the Western Electric Co., has resigned to accept a position as general sales manager of the M. S. Wright Co., Worcester, Mass., manufacturer of the "Pneuvac" vacuum cleaner. He is a graduate of the University of Michigan, class of 1894, and holds a degree in electrical engineering from that institution. Mr. King's experience with the Western Electric Co. dates from February, 1899, when he entered the power apparatus department in Chicago, becoming chief engineer of power apparatus in 1904, in which capacity he guided the development of a complete line of alternating-current generators and motors and many special direct-current generators. In January, 1908, Mr. King entered the sales field as assistant power apparatus sales manager at Hawthorne, being transferred to New York two years later as power apparatus sales manager, in which capacity he took a prominent part in the development of the so-called Western Electric specialties—washers, vacuum cleaners, etc. Last January he was appointed power and light sales manager, which position he held until he became connected with the Wright company.

H. R. King.

C. T. CLACK, president of the Milliken Brothers Manufacturing Co., Woolworth building, New York City, manufacturer of steel transmission towers, industrial buildings, etc., left Dec. 18 for a business trip around the world, to be absent for about eight months.

CHARLES LYMAN RAND, secretary and chief chemist of the Mitchell-Rand Manufacturing Co., New York City, manufacturer of electrical insulation products, has relinquished his duties as factory superintendent at the plant in Jersey City, N. J., to devote his entire time to important research work in the insulation and affiliated lines for his company. He will be succeeded as factory superintendent by Joseph T. Lawrence, formerly associated with E. I. du Pont de Nemours & Co. Mr. Rand is a graduate of Cornell University, class of 1904, and became connected with the Mitchell-Rand company in 1906.

OBITUARY.

CHARLES MANVILLE, vice-president of the H. W. Johns-Manville Co., manufacturer of electrical materials, died Dec. 29 at his home in Milwaukee, at the age of 54 years.

SAMUEL A. DUNCAN died last month at Atlanta, Ga., aged 71 years. He was prominent in electrical and telegraph circles until 15 years ago when he retired to engage in other business. In 1896 he was general superintendent of the Postal Telegraph-Cable Co., with headquarters in Atlanta. For many years Mr. Duncan was a resident of Pittsburgh and was active in telegraph circles until the advent of the electric light when he engaged in its development. He was president of the National Electric Light Association for one year.

ROBERT ALDEN MCCARTY, scientist, electrical inventor and boyhood chum of Thomas A. Edison, died Dec. 29 at the French Hospital, New York City, after a long illness. He was born in Guelph, Ont., 74 years ago and later resided in Port Huron, Mich., where he met Mr. Edison. Mr. McCarty served as a drummer boy with the Fourteenth Michigan Infantry in the Civil War. Following the war he entered Olivet College, Michigan, where he graduated in the science course. He was associated with Mr. Edison in the early days of the Edison institution and in 1881 helped him install the first electric system in New York City. In 1918 Mr. McCarty conceived a plan for harnessing the power of Niagara Falls for the generation of electricity and presented it to President Wilson. It was later approved and is one of the two plans now under consideration. Mr. McCarty was a member of the Edison Pioneers and the G. A. R., the funeral ceremonies being conducted by these two organizations, President William J. Hammer and Secretary Robert Lozier representing the Edison Pioneers.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Beverly, Mass.—The Beverly Gas & Electric Co. has made application to the Department of Public Utilities for permission to increase its capital stock from $687,000 to $825,000. The proceeds will be used for extensions and improvements in plant and system.

Cambridge, Mass.—The Charles A. Cook Co., 16 Osborn street, has construction under way on a new one-story power house at its works, 21 by 42 ft., to be used as an addition to present plant. A coal pocket will also be constructed.

Fitchburg, Mass.—The Fitchburg Gas & Electric Co. has construction under way on a new power house, machine works and general service building on the Sawyer Passageway, to be two-story, 59 by 153 ft., and estimated to cost about $95,000.

Lowell, Mass.—The Lowell Electric Light Corp. has arranged for a stock issue of $1,176,400, the proceeds to be used in part for the completion of the addition to the company's power plant, to provide for an increase of about 12,500 kw.

Springfield, Mass.—All equipment at the new local plant of the Diamond Match Co., now nearing completion, will be electrically operated. The plant consists of five buildings, one of which comprises an electric power plant, and represents an investment of about $1,000,000.

Springfield, Mass.—The United Electric Light Co., State street, has awarded miscellaneous contracts, including plumbing, heating, etc., for the completion of its new substation, 35 by 50 ft., at North and Carew streets. The station will be known as substation No. 4.

Bridgeport, Conn.—The city will install 50 tungsten and 50 arc lamps during the coming year. The board of aldermen is in charge.

Pawtucket, R. I.—Considerable electrical equipment will be installed in the new five-story addition to be erected at the plant of the Hope Webbing Co., Main street, manufacturer of narrow fabrics, etc. The extension will be 80 by 190 feet, and will include a power house, 20 by 26 ft., for works service. The project will cost about $300,000 with equipment. The Central Construction Co., Slater Trust building, has the construction contract.

Woonsocket, R. I.—Considerable electrical equipment will be installed in the new addition to be constructed at the plant of the Lafayette Worsted Co., Hamlet street, estimated to cost about $350,000.

Brooklyn, N. Y.—The Kings County Lighting Co., 4802 New Utrecht avenue, has filed notice of increase in capital from $2,000,000 to $4,000,000 for proposed extensions and betterments. Ralph Elsman is president.

Johnstown, N. Y.—The Cayadutta Generating Co. has been merged with the Fulton County Gas & Electric Co., under the latter name.

Long Island City, N. Y.—Considerable electrical machinery and equipment will be installed in the new nine-story printing house, 80 by 365 ft., to be erected by the Printers' Realty Co., New York, at Jackson and Hulst avenue, estimated to cost about $4,000,000.

New York, N. Y.—James B. Girand, care Parsons, Klapp, Brinckerhoff & Douglas, Edison building, has applied to the Federal Power Commission for permission for a license to develop power in the Colorado river, at Diamond Creek, Arizona, for railroad electrification and public utility purposes.

New York, N. Y.—The Department of Public Welfare has completed plans for extensions and improvements in the power plant at the hospital at Blackwells Island, 44 by 247 ft. Improvements and enlargements will also be made in the mechanical laundry plant at the works.

New York, N. Y.—The Federal Light & Traction Co. has leased property at 52 William street for new local headquarters.

New York, N. Y.—The James A. Hearn & Son Co., 20 West 40th street, has commenced the erection of the superstructure for its proposed new two-story power plant, 50 by 133 ft., at 26-28 West 13th street, to be used in connection with its department store. The structure is estimated to cost about $200,000.

New York, N. Y.—The New York Edison Co., Irving place and 15th street, has acquired property at 224-26 East 52nd street, to be used for operations in this district.

New York, N. Y.—The Phoenix Hydroelectric Corp. has been incorporated with a capital of $350,000 to construct and operate electric generating plants. The incorporators are C. E. Goehring, C. A. Hack and L. Schroeder, 1593 Lexington avenue, New York City.

New York, N. Y.—The United Electric Light & Power Co., 130 East Fifteenth street, will soon break ground for its proposed new electric generating plant on 134th street and the East river. Two buildings will be erected, comprising a power house and electric generating department in one structure, and switchboard gallery, office and service department in the other. The new plant will cost about $3,000,000 with machinery. The building contract was awarded recently to the United States Construction Co., 941 Broadway, New York.

North Tonawanda, N. Y.—Fire, Dec. 29, caused a slight damage at the plant of the Republic Light, Heat & Power Co., East Niagara street. The loss will be replaced at once.

Orangetown, N. Y.—The Rockland Light & Power Co. has filed notice of increase in capital from $1,300,000 to $1,600,000 for proposed expansions.

Atlantic City, N. J.—Abbott's Alderney Dairies, Inc., is planning for extensions and improvements in its two-story power house at 1411 Baltic avenue.

East Orange, N. J.—The city council is arranging for an appropriation of $60,000 for street-lighting during the coming year.

Elizabeth, N. J.—The Consumers Ice & Cold Storage Co., 1079 East Grand street, has awarded a contract to H. Wilhelms & Sons, 803 East Jersey street, for the erection of a one-story power house, 25 by 75 ft., to cost about $25,000.

Jersey City, N. J.—Considerable electrical equipment, including motors, etc., will be installed in the new lumber plant to be constructed by the Fulton Lumber Terminal Co., on a site near the city, recently acquired. The company was lately organized with a capital of $1,000,000. The works will include power house, electric hoisting and conveying equipment, motor drives for woodworking machinery, etc. B. F. Fitch, president of the Motor Terminal Co., 61 Broadway, New York, is interested in the new company.

Newark, N. J.—The Clinton Hill Improvers' Association is negotiating with the city commission for the installation of high-power street lights on Clinton avenue, from Broad street to Elizabeth avenue. Commissioner Raymond is in charge of the public highway department.

Plainfield, N. J.—Electrical equipment will be installed in the proposed new garbage incinerating plant to be constructed by the city. It is proposed to prepare plans to provide for the installation early in the spring. The common council is in charge. A. N. Vars, city hall, is city engineer.

Trenton, N. J.—Electrical equipment will be installed in the proposed addition to the McKinley Memorial Hospital, Brunswick avenue, forming a new wing, estimated to cost about $100,000. N. A. K. Bugbee, 206 East Hanover street, is chairman of the committee.

Allentown, Pa.—Fire, Dec. 25, destroyed a portion of the plant of the Allentown Steam Heating & Power Co., South Hall street, with loss estimated at about $70,000. The plant renders service in the business section.

Conshohocken, Pa.—The Hummel Electric Foundry Co. has completed the installation of a new high-voltage power station at its plant. The company resumed operations on Jan. 3 after a shut-down of several weeks.

Harrisburg, Pa.—The Public Service Commission has given approval for the merger of a number of electric

companies operating in the Cumberland valley section into the Cumberland Valley Light & Power Co. Farley Gannett is president.

Philadelphia, Pa.—The Bureau of Health, city hall, is perfecting arrangements for the erection of its proposed new one-story power plant addition at the Byberry Hospital for the Insane. Dr. C. L. Furbush is director.

Ridgeway, Pa.—The Keystone Electric Service Corp. has made application to the Public Service Commission for a merger of a number of companies, operating in Elk and adjoining counties, with its system.

Aberdeen, Md.—The Quartermaster Department has awarded a contract to the Belmont Iron Works, 32nd street and Washington avenue, Philadelphia, Pa., for the construction of a new power house and generator plant, in connection with a new hangar, at the local arsenal, at a cost of about $150,000.

Baltimore, Md.—The Baltimore & Ohio Railroad Co. is perfecting plans for the electrification of its system over the Allegheny Mountains, east of Grafton, primarily for freight service in this district. New power plants will be established in connection with the project.

Baltimore, Md.—The General Chemical Co., Munsey building, will soon award the building contract for the erection of its proposed new power plant at Winder and Race streets, 50 by 60 ft.

Baltimore, Md.—W. H. H. Stineman and Alfred M. Quick, Gunther building, have applied to the Federal Power Commission for a preliminary permit to construct a dam at High Island above Chain Bridge and at Plummer Island, 4 miles below Great Falls on the Potomac river, D. C., for public utility purposes.

Washington, D. C.—The Appropriation Committee of the House of Representatives is considering a fund of $10,000,000, to be used for the completion of the Wilson dam project at Muscle Shoals, Ala.

Langley Fields, Va.—The United States Government, Quartermaster Department, is planning for extensions and additions in the local radio station to cost about $50,000.

Richmond, Va.—Electric equipment will be installed in the plant of the Crystal Ice Co., 525 Brooks avenue, in connection with extensions and improvements in the present three-story building, to cost about $50,000.

Weyers Cave, Va.—The Weyers Cave Light & Power Co., recently organized, is planning for the operation of a hydroelectric power plant on the Shenandoah river. The initial capacity will be about 600 hp.

Winchester, Va.—The Front Royal-Riverton Milling Corp. is planning the establishment of a hydroelectric power plant on the Shenandoah river.

Charleston, W. Va.—The Meadow Creek Power Co. has been incorporated with a capital of $100,000 to operate an electric light and power system in Fayette and Greenbrier counties. The incorporators are Thomas B. Jackson, George S. Couch and V. L. Black.

Princeton, W. Va.—The Princeton Power Co. has been organized with a capital of $10,000, and will operate the electric railway between Princeton and Graham, Va. Improvements and extensions are contemplated. H. S. Hardy is president, T. E. DeJarnette is secretary, S. D. Evans, W. D. Shuff, and L. H. Perkins are directors, all of Princeton.

Granite Falls, N. C.—The Granite Falls Manufacturing Co., operating local cotton mills, is perfecting plans for the construction of a new hydroelectric power plant at Lenoir, to be used for general factory service, as well as light and power work.

Hickory, N. C.—The United Mills Co., manufacturer of cotton goods, is perfecting plans for the erection of a new hydroelectric power plant in the vicinity of Mortimer, for general mill operation and other light and power service.

Murphy, N. C.—Bonds in the sum of $25,000 have been voted for the purpose of improving the local electric light plant. C. B. Hill, town clerk, is in charge.

Greer, S. C.—Bonds in the sum of $40,000 have been voted for the purpose of building a power transmission line from Greer to Fairforest. Bids will be invited. W. N. Willis, Spartanburg, S. C., is engineer.

La Grange, Ga.—The common council has plans under way for extensions and improvements in the electric-lighting system to cost about $20,000. S. H. Dunson is mayor.

Quincy, Fla.—Plans are being perfected by the town council for extensions and improvements in the municipal electric power plant.

Sarasota, Fla.—The city council has disposed of a bond issue of $35,000, the proceeds to be used for extensions and betterments in the local electric light and power plant.

NORTH CENTRAL STATES.

Grand Rapids, Mich.—The Consumer Power Co. has plans under way for the erection of a power plant which is estimated to cost $400,000. George L. Erwin is general manager.

Grand Rapids, Mich.—The Wisconsin-Minnesota Light & Power Co., care Charles McPherson, 1107 Grand Rapids Savings building, has applied to the Federal Power Commission for a license to construct a dam and reservoir at the forks of Chippewa river, Sawyer county, Wisconsin, for public utility purposes.

West Allis, Wis.—The council has passed a resolution authorizing the installation of arc lights at Greenfield avenue and at Summit avenue, and the electric company will be asked to install these lights immediately.

Springfield, Ill.—The Springfield city council will install ornamental lights in the downtown district and will place underground the wires in the business district. The plan to install a boulevard lighting system in South Fifth street between Ash and Broad streets will be abandoned and an overhead lighting system will be provided.

Duluth, Minn.—Plans for a direct power transmission line from the Thomson power plant of the Great Northern Power Co. to the plant of the Duluth Edison Electric Co. were disclosed in a petition to the district court for the appointment of a board of appraisers in condemnation proceedings to obtain the necessary right of way. The Duluth Edison Co. will construct a power transmission line direct from the Carlton county power plant to Duluth.

Nelson, Minn.—The Nelson Light & Power Co., in which Fred C. Sheldon and others are interested, has been organized with a capital of $25,000.

Jefferson City, Mo.—The Missouri Gas & Electric Service Co. is planning for electric plant extensions and improvements to cost $68,700. The Public Service Commission recently granted the company permission to issue bonds for this amount for the proposed work.

Springfield, Mo.—The city council, Ash Grove, is considering the construction of a new electric transmission line to Springfield and other points in connection with local power operation.

Scribner, Nebr.—The Farmers' Light & Power Co., in which Peter J. Bauer is interested, has been organized with a capital of $25,000.

SOUTH CENTRAL STATES.

Carrollton, Ky.—Bids will be received Jan. 12 by J. E. Gullion, mayor, for an electric light plant and waterworks improvement to cost about $18,000.

Irvine, Ky.—The Irvine Light & Power Co. is planning extensions in its local electric power plant to cost about $12,000.

Paducah, Ky.—The city will install additional generating equipment in the electric light plant. The mayor is in charge.

Praise, Ky.—The Elkhorn-Cumberland Coal Co. is planning the erection of an electric power plant at its properties at Elkhorn City.

Gadsden, Ala.—The Alabama Power Co. will expend $100,000 to improve and extend the Gadsden street railway.

Amory, Miss.—Bonds have been issued for the purpose of constructing an electric light and water plant.

Belcher, La.—The borough council is planning for the rebuilding of the municipal electric lighting plant, recently destroyed by fire.

Hindsville, Ark.—The city council has plans under way for the installation of an improved electric street-lighting system.

Little Rock, Ark.—The Garland Hydroelectric Power Co., care Lemuel Sparkman, 113 Fulk building, has applied to the Federal Power Commission for a license to construct two dams and reservoirs and one power house on the Ouachita river near the boundary between Montgomery and Garland counties, Arkansas, for public utility purposes.

Bangs, Tex.—John Sanders is organizing a company for the construction and operation of a local electric power plant and distributing system.

Hallettsville, Tex.—The city council is planning for the installation of new engine and other equipment at the municipal power plant to cost about $20,000.

Bonham, Tex.—The city council is arranging for a bond issue of $150,000 for the installation of a municipal electric light and power plant.

Waxahachie, Tex.—The city council has preliminary plans under way for the construction of a new ornamental street-lighting system in the Getzendaner Memorial Park.

WESTERN STATES.

Idaho Falls, Ida.—Mrs. Nellie P. Bean, care Cotton & Wilson, Post building, has applied to the Federal Power Commission for a preliminary permit to construct a dam 9 ft. high and a 10-ft. pipe line to the power house on the Warm river between Mesa and Warm river, Fremont county, Idaho, for public utility purposes.

Brigham City, Utah.—The mayor and city council have definitely decided upon the site on which will be erected the municipal electric light plant, which will be designated to generate the maximum power from Boxelder creek, or approximately 1200 hp.

Olympia, Wash.—A. G. West and Fred W. Lewis have petitioned to the county commissioners for a franchise to construct, maintain and operate an electric light and power line beyond Tumwater and to embrace the Brighton Park district and South Union.

Seattle, Wash.—Frank L. Ballaine, care James A. Haight, 702 Haight building, has applied to the Federal Power Commission for a preliminary permit to construct a diversion dam, and an 11-mile conduit with two power houses for pulp, paper mill and public utility purposes.

Spokane, Wash.—Lloyd E. Gandy, 803 Sherwood building, has applied to the Federal Power Commission for a preliminary permit to construct a dam, reservoir and power house on the Spokane river at Fort George Wright, Washington.

Los Angeles, Cal.—Tyler Electric Co. To manufacture electrical specialties. Incorporators: A. S. Tyler, 2949 West 15th street, and others.

Los Angeles, Cal.—The Southern California Edison Co., Edison building, has applied to the Federal Power Commission for a preliminary permit to construct a dam, conduit and power house on San Joaquin river below the mouth of Big creek, in Fresno county, California. The project is designed for public utility purposes.

San Francisco, Cal. — Frank G. Baum, 1901 Hobart building, has applied to the Federal Power Commission for a license to develop power on the Black river, Arizona.

San Francisco, Cal.—The Southern Sierras Power Co., care W. L. Huber, First National Bank building, has applied to the Federal Power Commission for a license to construct a transmission line from the power house to connect with the existing transmission system of the applicant at a point in Inyo county, California. The project is designed for public utility purposes.

CANADA.

Richmond Hill, Ont.—The development of a water-works system is under way, for which the E. A. James Co., 36 Toronto street, Toronto, is engineer. Electrically driven centrifugal pumps will be installed. The total cost is estimated at $95,000.

Brantford, Ont.—Fire, recently destroyed the Lake Erie & Northern power plant. Plans are now under way for the reconstruction of the building, and equipment to be purchased is estimated to cost about $110,000.

Edmonton, Atla.—A bylaw will be submitted to the voters by the city council, for the purpose of making an extension to the municipal power plant.

INCORPORATIONS.

Fairmount, Minn.—Fairmount Electrical Co. Capital, $25,000. Incorporators: Henry C. Wehrenberg and others.

Cincinnati, O.—Electric Railway Equipment Co. Capital, $300,000. Incorporators: W. Andrews, F. Andrews and others.

Cleveland, O. — Cleveland Electric Condenser Co. Capital, $50,000. Incorporators: J. J. Larick, H. Wells, G. R. Rogers and others.

Wallington, N. J.—Electrical Material Co. To manufacture electrical equipment. Incorporators: Walter L. Fischer, George Emerson and others.

Rochester, N. Y.—Rochester Electric Carbon Brush Corp. Capital, $10,000. Incorporators: J. P. Thompson, G. F. Hixson, B. Ferris and others.

Olean, N. Y.—Harold Electric Shop. Capital, $10,000. To engage as electrical contractors. Incorporators: J. B. Harold, C. W. Gabler and H. Herold.

Troy, N. Y.—Chadburn Engineering Co. Capital, $10,000. To engage as electrical engineers. Incorporators: C. C. Gregson, T. Arnold and W. R. Chadburn.

Philadelphia, Pa. — William B. Young Co. To manufacture electric fixtures, etc. Incorporators: Harnitz and King, Bergner building, Harrisburg, Pa.

Delhi, N. Y.—Farmers Light & Power Co. Capital, $20,000. To manufacture electrical machinery, etc. Incorporators: F. W. Thomson, R. S. Marvin, R. Archibald and others.

Pittsburgh, Pa.—National Electric Tool Co. To manufacture electrical tools and other equipment. Incorporators: John A. Metz, 707 B. F. Jones Law building; Thomas D. Murray and S. E. Bentley.

New York, N. Y.—J. O. Ross Engineering Corp. Capital, $105,000. To manufacture heating and ventilating equipment. Incorporators: B. G. Smith, F. W. Bolowicz and E. P Murphy, 30 East 42d street.

Marshfield, Wis.—Marshfield Farm Electric Co. Capital, $20,000. To manufacture electrogenerating units and appurtenances for farms and isolated places. Incorporators: J. P. Adler, J. P. O'Connell and R. F. Finucane.

Boston, Mass.—Utility Manufacturing & Sales Corp. Capital, $300.000. To manufacture electrical equipment and engage as electrical engineers. Incorporators: Arthur J. Driscoll, Jamaica Plains; George E. Williams and A. C. Drew, Boston.

Newark, N. J.—Sun Electric Lamp Co. Capital, $50,000. To manufacture electric lamps. Incorporators: Ralph C. and L. F. Dick and August B. Rosasco.

Montreal, Can. — The Montreal Light, Heat & Power Co., has arranged for a bond issue of $150,000, the proceeds to be used for necessary expansion.

New York, N. Y.—Intercity Radio Co. Capital, $50,000. To construct and operate radio plants. Incorporators: E. J. Simon, E. W. Sawyer and A. A. Raphael, 31 Liberty street.

New York, N. Y.—Spielman Electric Co. Capital, $30,000. To manufacture electrical products. Incorporators: M. H. Spielman, 995 Alder avenue; S. Spielman, B. M. Asch and others.

Long Beach, Cal.—Lentz Electric Co. Capital, $75,000. To manufacture electrical specialties. Incorporators: F. O. Lentz, George A. Hart, T. D. Caustic and others.

Pittsburgh, Pa.—Anchor Lite Appliance Co. To manufacture electrical appliances and supplies. Incorporators: Jacob L. Simon, 1409 Park building; A. S. Goldstein, E. J. Kelsky and others.

Detroit, Mich.—Telltale Spark Plug Co. Capital, $50,000. To manufacture patented spark plugs and other ignition equipment. Incorporators: Isaac Harris, 5641 Carnes avenue; O. H. Talines, I. Ransom and others.

FOREIGN TRADE.

[Addressee of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Lighting Fixtures, etc., (34,156)—An engineering and trading company in India desires to be placed in communication with manufacturers only of direct and semi-indirect lighting fixtures, switches, motors, farm lighting plants, centrifugal pumps, fans and heating appliances.

Engines (34,162)—An American residing in India desires to receive catalogs and approximate prices on Diesel oil engines of from 100 to 1500 hp. or more, both in two- and four-cycle types, these to be considered for both industrial plant and central-station service.

Electrical Apparatus (34,183)—The partner in an import firm of South Africa is in the United States and desires to secure an agency for the sale of equipment for house-lighting plants, electrical household contrivances, etc. Reference.

Electrical Goods (34,213)—A commercial agent from Australia is in the United States and desires to secure an agency for the sale of electrical goods, etc. Reference.

PROPOSAL.

Darlington, Wis.—Sealed proposals will be received at the office of the city clerk until 7:30 p. m., Jan. 14, for furnishing one centrifugal pump and one 20-hp. wound-rotor induction-type motor complete with starting equipment.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Offering of Middle West Utilities Co. Notes.

Halsey, Stuart & Co. and A. B. Leach & Co., Chicago, are offering an issue of $2,134,000 Middle West Utilities Co. twenty-year 8% secured gold notes, series "B," dated Dec. 1, 1920, at 95.25 and interest, yielding about 8½%. The Middle West Utilities Co. through its subsidiary companies operates in the following fifteen states: Illinois, Indiana, Kentucky, Maine, Michigan, Missouri, Nebraska, New Hampshire, New York, Oklahoma, Tennessee, Texas, Vermont, Virginia and Wisconsin. The company's subsidiaries serve 496 communities—a combined estimated population of 1,317,200. On October 31, 1920, electric customers numbered 221,881, gas 54,784, water 24,778, a total of 301,443 customers for these services alone. The earnings of the Middle West Utilities Co. as officially reported, for the twelve months ended Oct. 31, 1920, show a net balance of $2,281,670.90 available for the annual interest of $996,910 on $4,634,000 8% secured gold notes, Series "A" and "B," $9,336,500 ten-year 6% collateral gold bonds and $1,100,000 three-year 6% gold notes.

Columbia Gas & Electric Co. Declare Extra Dividend.

Directors of the Columbia Gas & Electric Co. today declared an extra dividend of $1 a share, payable Jan. 25 to stock of record Jan. 10. This makes total cash dividends paid for the year 6%. It was announced that the company's net earnings for 1920 will exceed $5,000,000, or more than 10% on the stock.

Bond Issue of Cincinnati Gas & Electric Co. Approved.

Stockholders of the Cincinnati Gas & Electric Co. have voted approval of the proposal to authorize $50,000,000 bonds, to be a prior lien and refunding mortgage. The bonds will run 40 years, with sinking fund provisions. They will be issued at such times as the company's financial needs demand and will bear such interest as market conditions at time of sale require.

Cumberland County Power & Light Co.

	1920.	1919.
October gross	$ 266,639	$ 241,017
Net after taxes	87,330	96,277
Surplus after charges.	31,486	40,427
Twelve months' gross.	3,068,326	2,830,052
Net after taxes	1,031,650	875,343
Surplus after charges.	364,298	169,814

Nashville Railway & Light Co.

	1920.	1919.
October gross	$ 314.598	$ 269,205
Net after taxes	46,312	65,299
Surplus after charges.	5.886	25,530
Twelve months' gross.	3,609,887	3,184,748
Net after taxes	665.657	808.942
Surplus after charges.	185,366	335,969
Balance after preferred dividends	60,366	210,969

Manila Electric Railway & Lighting Corp.

	1920.	1919.
November gross	$ 320,282	$ 247,587
Net after taxes	131,210	65,511
Total income	131.273	66.274
Surplus after charges.	82,353	29,646
Twelve months' gross.	3,379,766	2,554,554
Net after taxes	1,156,814	842,942
Total income	1,158,335	844.834
Surplus after charges.	746,769	517,006
Balance after preferred dividends	446,769	217,006

Northern States Power Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$11,471,141	$9,726,147
Net earnings	4,372,510	4,095,104

Arkansas Valley Railway, Light & Power Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$1,846,274	$1,557,260
Net earnings	603,194	553,446

Fort Smith Light & Traction Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$1,057,133	$822,513
Net earnings	301,071	267,467

Schenectady Railway Co.

	1920.	1919.
November gross	$ 165,481	$ 142,793
Net after taxes	23,597	14,727
Total income	23,744	14,846
Surplus after charges.	11,216	2,368
Eleven months' gross.	1,727,780	1,505,699
Net after taxes	163,695	171,161
Total income	165,083	171,955
Surplus after charges.	27,692	32,919

Carolina Power & Light Co.

	1920.	1919.
October gross	$ 153,839	$ 128,377
Net after taxes	42,124	37,397
Total income	45,652	39,216
Surplus after charges.	27,818	23,396
Twelve months' gross.	1,549,067	1,200,197
Net after taxes	429,342	398,305
Total income	601,912	552,038
Surplus after charges.	396,569	360,816
Balance after preferred dividends	262,639	234,813

Philadelphia Rapid Transit Co.

	1920.	1919.
November gross	$3,726,376	$3,055,953
Net after taxes*	1,137,244	990,814
Total income	1,192,200	1,032,844
Surplus after fixed charges	372,926	218,989
Eleven months' gross.	34,917,705	32,216,937
Net after taxes	9,322,972	10,122,756
Total income	9,854,238	10,606,098
Surplus after fixed charges	858,306	1,682,748

*Includes payment of full wage scale for the month.

Louisville Gas & Electric Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$4,384,866	$3,546,922
Net earnings	2,069,149	1,796,036

San Diego Consolidated Gas & Electric Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$2,600,943	$2,267,123
Net earnings	866,796	743,660

Western States Gas & Electric Co.

Twelve months ended Nov. 30:

	1920.	1919.
Gross earnings	$2,207,139	$1,870,999
Net earnings	824,681	774,977

Nevada-California Electric Corp.

	1920.	1919.
November gross	$ 205,052	$ 181,203
Net after taxes	109,363	88,819
Total income	108,449	88,082
Surplus after charges	47,318	30,322
Eleven months' gross	2,848,493	2,361,211
Net after taxes	1,521,475	1,294,362
Total income	1,514,366	1,291,402
Surplus after charges	862,621	654,652

Alabama Power Co. & Subsidiaries.

	1920.	1919.
November gross	$ 397,416	$ 289,411
Net after taxes	2,089,126	1,578,799
Twelve months' gross	4,098,492	2,944,984

Dividends.

	Term.	Rate.	Payable.
Cen. Ill. Pub. Ser. pf.	Q	1.50%	Jan. 15
Col. Gas. & Elec.	Ext.	$1.00	Jan. 25
Louis. Gas & El. pf.	Q	1.75%	Jan. 15
North. States Pr. pf.	Q	1.75%	Jan. 20
Pacific G. & El. com.	Q	$1.25	Jan. 15
Puget S. Pr. & Lt.	Q	75c	Jan. 15
West. Pr. pf.	Q	1.50%	Jan. 15
West. S. Gas & El. pf.	Q	1.75%	Jan. 15
West. Penn. Pr. pf.	Q	1.75%	Feb. 1
Westinghouse com.	Q	2%	Jan. 31
Westinghouse pf.	Q	2%	Jan. 15

WEEKLY COMPARISON OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

	Div. rate. Per cent.	Bid Dec. 28.	Bid Jan. 4.
Public Utilities—			
Adirondack Electric Power of Glens Falls, common	6	10	11
Adirondack Electric Power of Glens Falls, preferred	6	70	71
American Gas & Electric of New York, common	..	94	93
American Gas & Electric of New York, preferred	6	32	31
American Light & Traction of New York, common	..	65	68
American Light & Traction of New York, preferred	6	66	67
American Power & Light of New York, common	4	39	41
American Power & Light of New York, preferred	6	58	59
American Public Utilities of Grand Rapids, common	..	6	7
American Public Utilities of Grand Rapids, preferred	7	15	15
American Telephone & Telegraph of New York	..	95	98
American Water Works & Elec. of New York, common	..	½	¾
American Water Works & Elec. of New York, particip	7	4	4½
American Water Works & Elec. of New York, 1st preferred	..	35	36
Appalachian Power, common	..	1½	2
Appalachian Power, preferred	7	16	17
Cities Service of New York, common	+extra	231	232
Cities Service of New York, preferred	6	62	62
Commonwealth Edison of Chicago	8	101	102
Comm. Power, Railway & Light of Jackson, common	..	9	10
Comm. Power, Railway & Light of Jackson, preferred	6	29	29
Federal Light & Traction of New York, common	..	5	5
Federal Light & Traction of New York, preferred	..	42	43
Northern States Power of Chicago, common	..	33	34
Northern States Power of Chicago, preferred	ex.div.7	74	76
Pacific Gas & Electric of San Francisco, common	..	45	47
Public Service of Northern Illinois, Chicago, common	7	57	58
Public Service of Northern Illinois, Chicago, preferred	6	75	76
Standard Gas & Electric of Chicago, common	..	9	10
Standard Gas & Electric of Chicago, preferred	8	29	30
Tennessee Railway, Light & Power of Chattanooga, common	..	½	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	1½	1½
Western Power of San Francisco, common	..	18	20
Western Union Telegraph of New York	extra	34	77
Industrials—			
Electric Storage Battery of Philadelphia, common	4	97	99
General Electric of Schenectady	8	117	118
Westinghouse Electric & Mfg. of Pittsburgh, common	7	41	42